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BEPy



AIR QUALITY ASSESSMENT STUDIES IN THE SUDBURY AREA

VOLUME 2

EFFECTS OF SULPHUR DIOXIDE
AND HEAVY METALS ON
VEGETATION AND SOILS
1970 - 1977

AUGUST - 1978



Ministry
of the
Environment

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Air Quality Assessment Studies in the Sudbury Area

Volume 2

Effects of Sulphur Dioxide and Heavy Metals on
Vegetation and Soil, 1970-1977

Technical Support Section

Ontario Ministry of the Environment

Northeastern Region

Sudbury

August - 1978

TABLE OF CONTENTS

	<u>PAGE</u>
I Summary.....	1
II Introduction.....	1
III Sulphur Dioxide Monitoring.....	2
IV Potentially Injurious Fumigations.....	4
V Complaints of Vegetation Injury by Air Pollutants.....	6
VI Vegetation Injury Observed in 1975, 1976 & 1977.....	7
(a) Injury Caused by Air Contaminants...	7
(b) Vegetation Injury Caused by Other Agents.....	8
VII Sampling and Chemical Analysis of Vegetation and Soil (1970-1976).....	11
(a) Program Outline	11
(b) Excessive Values	12
(c) Elemental Analysis of Vegetation....	13
(d) Elemental Analysis of Soil.....	16
(e) Summary of Results of Vegetation and Soil Sampling Program.....	19
VIII Bibliography.....	20
IX Acknowledgements.....	22
X Appendix	23

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I SUMMARY:

The effects of sulphur dioxide and heavy metals emitted from smelters in the Sudbury area have been monitored by the Ontario Ministry of the Environment since 1970. Air quality monitoring at seventeen locations around Sudbury has shown that the number of potentially injurious fumigations by SO₂ has decreased from between 34 to 80 prior to 1972 to 8 to 19 after 1972. Observed acute SO₂ injury to vegetation has also decreased. A total of 241 complaints of injury to vegetation were examined in the period 1970 to 1977 of which approximately 40% were diagnosed as contaminant injury. Permanent vegetation plots were established in the Sudbury area at 21 locations in 1970. Samples of soil and foliage of several plant species were collected several times during the growing season each year from 1970 to 1976. The results of chemical analysis of these samples indicated that nickel, copper, sulphur and to a lesser extent arsenic and selenium concentrations were elevated in the vicinity of the smelters (Sudbury, Garson, Skead). Concentrations decreased with distance from the smelters.

This report summarizes the data from all of the above programs for the years 1970 to 1977.

II INTRODUCTION:

Emissions, primarily sulphur dioxide and heavy metals, from the Sudbury area smelters of INCO Metals Company and Falconbridge Nickel Mines have been responsible for a considerable amount of injury to vegetation in the Sudbury region. These injuries and alterations of the forest environment have been investigated, and documented by a number of agencies and researchers (2,3,7,8,9,10). This report is a summary of data obtained during the investigations conducted by the Ontario Ministry of the Environment from 1970 to 1977. Emphasis has been placed on changes in vegetation injury resulting from the air quality improvement since 1972.

The Ministry of the Environment monitored sulphur dioxide emissions from the nickel smelters at seventeen locations in the 1975, 1976 and 1977 growing seasons. Davis conductimetric SO₂ monitors were utilized at the Lake Temagami, Grassy Lake, St. Charles, Morgan, Garson, Rayside, Hanmer, Skead, Callum, Burwash, Penage, Verner and Chiniguchi Lake stations. At the urban monitoring locations such as Ash Street (Sudbury), Coniston and Lockerby, Beckman 906A coulometric monitors were employed. In this report the levels of SO₂ monitored at these locations are related to the vegetative effects noted in the field during the 1975 and 1976 growing seasons.

In accordance with the Environmental Protection Act, a total of 73 complaints of possible vegetation injury by air pollutants were investigated and reported upon during 1975, 1976 and 1977. As well, Ministry personnel conducted a general surveillance program throughout the growing seasons to assess the degree and extent of vegetation injury in the Sudbury area by air pollutants and other pathological agents.

In 1970, the Phytotoxicology Section of the former Air Management Branch began sampling vegetation and soil in the Sudbury area at a number of locations for chemical analysis. Air Quality Assessment staff of the Northeastern Region have continued this program. Over the years this program has been modified following examination of each year's data. The results of the chemical analyses from 1970 to 1976 are summarized in this report.

III SULPHUR DIOXIDE MONITORING

The sulphur dioxide monitoring network initially consisted of 5 Thomas autometers in 1953 located at Burwash, Skead, Grassy Lake, Garson and Lake Penage. Since 1953, the network has been expanded into areas where vegetation was being injured by sulphur dioxide. During 1975 the network consisted of 16 locations. The locations of these stations and of the smelters are shown in Figure 1. The network was comprised of 13 Davis conductivity instruments and 3 Beckman coulometric instruments. The Davis instruments were all located at stations well-removed from the other sources of pollutants in order to avoid interferences in the measuring cell. The Beckman instruments, on the other hand, respond solely to sulphur dioxide and are thus routinely used in urban areas without fear of interferences from other air pollutants. These latter instruments are located at Ash Street in Sudbury, in the town of Coniston (both stations are Air Pollution Index Stations), and on Caswell Drive (Lockerby Plaza) in Sudbury. This last station went into operation in May of 1975.

The Kukagami Lake station was shut down in the fall of 1974 and in July of 1975 a station was installed at Chiniguchi Lake. Another station was installed at Lake Temagami (Bear Island) in June, 1975. All of the stations, except for Chiniguchi Lake, Grassy Lake and Lake Temagami are winterized and are operated on a year-round basis.

During 1975, INCO Metals were closed from July 8 to July 21 and Falconbridge Nickel Mines were closed from August 21 to November 10 as a result of labour strikes. The Falconbridge operation was also suspended from September 11 to October 9, 1977.

In 1976 and 1977 the monitoring network was essentially the same as that of 1975. Sulphur dioxide data were also available from the Air Pollution Index station established in New Sudbury in March 1976.

A summary of the SO₂ monitoring data collected during the period from May to October, 1975 at each of the 16 stations is presented in Table 1. A more complete analysis of the data has been published in a separate report (13). The summer data from the two Air Pollution Index Stations (Ash Street in Sudbury and Coniston) and Caswell Drive (Lockerby area - Sudbury) have been included in this present report.

Over 62,500 hourly readings were recorded on 2,608 operative days. More than 62,000 of the hourly readings were less than .25 ppm. The Ontario criterion of .25 ppm for 1 hour was equalled or exceeded on 228 occasions. Thirty hours were greater than .50 ppm and 6 hours exceeded the 1.0 ppm level. The highest hourly reading (1.75 ppm) was recorded at Skead on September 20th.

In Tables 2 and 3, the SO₂ monitoring data for the May to October period of 1976 and 1977 respectively are summarized. A more complete analysis of this data is included in the companion volume to this report (1). The Ontario criterion (0.25 ppm for 1 hour) was equalled or exceeded on 341 occasions in 1976 and on 332 occasions in 1977.

In 1972, both INCO Metals and Falconbridge Nickel Mines instituted measures to reduce ground level concentrations of SO₂ through reduced SO₂ output and more effective atmospheric dispersion. The measures which were used included:

- 1) The closing of the INCO Metals smelter at Coniston and the pyrrhotite plant at Falconbridge prior to the 1972 growing season.
- 2) Limiting the SO₂ output from the INCO Metals iron ore recovery plant to 250 tons/day in April, 1972.
- 3) The introduction of the 381 m stack at the INCO Metals Copper Cliff smelter in August, 1972.
- 4) Vacation periods closed the smelters at both companies during late July or early August in 1972 and 1973.

Operational changes also resulted in a decrease of emitted annual SO₂ tonnage from both INCO Metals and Falconbridge Nickel Mines, as shown in Figures 2 and 3. The 1969 emissions were reduced due to extensive labour strikes experienced by both companies.

In order to assess the impact of these abatement measures on the air quality in the Sudbury area, the SO₂ ground level concentration data from the Ministry's SO₂ monitoring network were compiled and analyzed covering the period 1967 to 1977. This approach allows a comparison of SO₂ levels both before and after 1972, which in this case is taken as a transition year. Histograms of SO₂ average concentrations were prepared for each year for each station, showing: the total number of hours monitored; the average concentration of SO₂; and the total number of times the Provincial one-hour and 24 hour criteria were exceeded. The periods 1967 to 1971 and 1973 to 1977 are illustrated on each histogram. The SO₂ average concentration for each year is indicated by the height of the bar, except for 1972 for which the average is represented by the horizontal line segment across the dotted line. The period covered each year was May through October.

The data presented in the histograms (Figures 4 to 12) indicate that at most locations, the ground level concentrations of SO₂ have decreased appreciably since 1972 in the Sudbury basin. However the average SO₂ concentrations have increased slightly at St. Charles (Figure 12).

IV POTENTIALLY INJURIOUS FUMIGATIONS:

The Sudbury area has had a history of typical acute sulphur dioxide injury to vegetation during the growing season (May to October). Initially, most of the Sudbury area SO₂ monitors were established at locations where vegetation injury by SO₂ was most frequent and most severe. The establishment of these monitors made it possible to relate the appearance of injury to vegetation to fumigations of varying duration and SO₂ concentration.

From some of the first attempts to relate vegetation injury to SO₂ fumigations under controlled environmental conditions, Tebbins and Hutchinson (14) derived the following equation:

$$t = \frac{0.8}{C - 0.2}$$

where t = time required to cause injury and C = concentration of SO₂ in ppm.

This means that injury could occur under the following conditions:

1.0 ppm	SO ₂	for 1 hour
0.6 ppm	SO ₂	for 2 hours
0.4 ppm	SO ₂	for 4 hours
0.3 ppm	SO ₂	for 8 hours

The limitations of this relationship include 1.5 ppm SO₂ as a maximum concentration and assumes that a constant 0.2 ppm SO₂ will not cause acute injury. It also assumes that no injury will result from fumigations during periods of darkness since the stomata will be closed in dark periods and therefore SO₂ will be prevented from entering the leaf.

In 1963, Dreisinger (4,5) attempted to relate the applicability of the Tebbins and Hutchinson equation to the Sudbury field situation. It was found that injury could occur under the following conditions:

0.95 ppm	SO ₂	for 1 hour
0.55 ppm	SO ₂	for 2 hours
0.35 ppm	SO ₂	for 4 hours
0.25 ppm	SO ₂	for 8 hours

If any of these conditions were met in the daylight hours then the fumigation intensity was assigned a value of 100 for convenience. If the fumigation intensity value was 100 or over, then the fumigation was termed a potentially injurious fumigation (P.I.F.). A P.I.F. does not always result in injury since other factors such as species sensitivity, growing season and environmental factors also have some bearing on susceptibility to injury.

The following equations illustrate the method of calculating the fumigation intensity.

If 0.95 ppm SO₂ for 1 hour = Fumigation Intensity of 100
 Then x ppm SO₂ for 1 hour = $\frac{100}{.95} = 105 \times$

Similarly x ppm SO₂ for 2 hours = 182 x
 x ppm SO₂ for 4 hours = 286 x
 x ppm SO₂ for 8 hours = 400 x

Using this relationship, the number of P.I.F.'s at each monitoring station could be determined. Using the data available from the monitors operating in 1970, Dreisinger prepared a figure showing those areas subject to different numbers of P.I.F.'s. Figure 13 has been modified from Dreisinger's work (6). The greatest numbers of P.I.F.'s were measured in the Garson to Skead area with a total of 19 recorded at Garson and 24 recorded at Skead during 1970. Decreasing numbers were recorded with increasing distances from the smelters.

In contrast with the 1970 situation, the numbers of P.I.F.'s in the last three years have been substantially reduced. These observations are illustrated in Figures 14, 15 and 16. Some variability in the number of P.I.F.'s exists from year to year. Labour strikes in 1958, 1966 and 1969 brought about a decrease in the number of P.I.F.'s during those years. Since 1972, there has been a marked reduction in the number of potentially injurious fumigations. This reduction is more dramatic when one considers that between 1970 and 1977, the number of monitors used in this evaluation has been increased from 10 to 17. The inclusion of data from the Ash Street monitor in 1971 added 27 potentially injurious fumigations. In addition, the total number of fumigations with intensities over the 200 level decreased. In previous seasons, fumigations with intensities as high as 400 had been recorded. A summary of the number of P.I.F.'s recorded and the number of monitors employed each year since 1965 is provided in the following table:

YEAR	NUMBER OF POTENTIALLY INJURIOUS FUMIGATIONS	NUMBER OF MONITORS
1965	42	10
1966 (strike year)	35	10
1967	73	10
1968	50	10
1969 (strike year)	34	10
1970	64	10
1971	88	11
1972	36	12
1973	8	13
1974	17	14
1975 (strike year)	9	16
1976	19	17
1977	19	17

A summary of the dates, frequency and intensity of P.I.F.'s recorded at each monitoring station in 1975, 1976 and 1977 is included in Tables 4, 5 and 6 respectively. Similar information for the years prior to 1975 has been included in earlier reports (11, 12). The yearly maximum fumigation intensities at each monitoring location from 1970 to 1977 are presented in Table 7. The maximum values recorded in five of the years over this time period occurred at Skead while Garson and Rayside accounted for the remaining maximum intensities. A summary of the numbers of P.I.F.'s at each monitoring location in Sudbury from 1967 to 1977 is included in Table 8.

V COMPLAINTS OF VEGETATION INJURY BY AIR POLLUTANTS:

A total of 31 complaints in 1975, 30 complaints in 1976 and 12 complaints in 1977 of possible air pollution injury to vegetation in the Sudbury area were received and investigated by personnel of the Ministry of the Environment. The complainants subsequently received reports on the results of the investigations.

The numbers of complaint notifications of air contaminant injury to vegetation received during the past 8 years are shown in the table below, together with the number diagnosed as exhibiting contaminant injury.

<u>YEAR</u>	<u>NUMBER OF COMPLAINTS RECEIVED</u>	<u>NUMBER OF COMPLAINTS DIAGNOSED AS</u>		
		<u>SO₂ INJURY</u>	<u>OTHER CONTAMINANT</u>	<u>NON-CONTAMINANT</u>
1970	16	9	-	7
1971	14	10	-	4
1972	27	15	-	12
1973	65	15	-	50
1974	46	20	1	25
1975	31	6	8	17
1976	30	6	3	21
1977	12	2	3	7

Eight complaints made in 1975 involved an undetermined air contaminant which produced black spotting injury to the foliage of many plant species. This type of injury has not been observed in other years.

The majority of the complaints involved injury to vegetation caused by insects, pathological agents, physiological stresses and poor cultural practices. Samples collected during complaint investigations formed the bulk of the samples submitted for pathological examination.

In 1971, the Ontario Environmental Protection Act was enacted. Under this legislation, a Board of Negotiation was established to provide for the mediation of claims for damage to livestock and vegetation. To date only two claims, made in 1974, in the Sudbury area were negotiated in 1975 in the presence of the Board. The remainder presumably have been satisfactorily resolved by the two parties involved.

VI VEGETATION INJURY OBSERVED IN 1975, 1976 & 1977

a) Injury Caused by Air Contaminants

Detailed surveillance programs conducted during the growing seasons of 1975 and 1976 by personnel of the Ministry of the Environment showed only restricted injury to vegetation by SO₂. Widespread injury was not observed in either year. A limited surveillance program in 1977 revealed that similar levels of plant injury occurred in that year.

In late July 1975, an air pollutant injury episode occurred in the south-west portion of the City of Sudbury (Figure 17). A black spotting symptom was present on most broadleaf plant species (which had exposed foliage) in the affected area. The cause of the spotting has not been determined however tests to discover the identity of the causal agent are continuing.

In late May, 1975, a fumigation of SO₂ caused acute SO₂ injury on alfalfa and red clover in Balfour Township, 16 km north of Sudbury. The injury was trace in nature (1 - 5% of leaf area affected) and occurred over a relatively small area. In general less than 10% of the legumes in any field examined were injured. Indigenous tree species such as white birch and trembling aspen which are sensitive to SO₂ were not injured by this fumigation. The source of the SO₂ was the INCO Metals smelter at Copper Cliff.

On June 1, 1975, an SO₂ fumigation with an intensity of 101 was recorded at the Coniston monitor. Severe SO₂ injury (more than 35% of the leaf area affected) occurred on a few trembling aspen trees in the Coniston area as a result of this fumigation. Winds in the Sudbury area were out of the north and northwest during the daylight hours of June 1 therefore it can logistically be assumed that the Falconbridge Nickel Mines smelter, was the source of this fumigation.

In late June, severe SO₂ injury occurred on trembling aspen trees about 8 km north of Sudbury. Trembling aspen trees over about a 0.5 hectare area were affected. Severe SO₂ injury also occurred on trembling aspen trees located about 3 kilometres northwest of Sudbury about this time. Approximately 0.5 hectares were involved with this incident.

The 1975 season was the first year that no acute SO₂ injury occurrence was noted during July or August since the inception of the vegetation surveillance program by the Department of Mines in the mid 1940's. The lack of SO₂ injury in 1975 was attributed to the:

- 1) Reduced SO₂ emissions as a result of several changes instituted at the area smelters and refineries in 1972.
- 2) Limited rainfall during July and August which lowered the sensitivity of the vegetation to SO₂.
- 3) Closure of INCO Metals from July 8 to July 21 and Falconbridge Nickel Mines Ltd. from August 21 to November 10 as a result of labour strikes.

The locations where trace to light sulphur dioxide injury was recorded in 1976 are shown in Figure 19. The most severely injured crops were clover and alfalfa, both of which are highly susceptible to SO₂ injury. The tree species most commonly injured was trembling aspen. All injury, when discovered, was not fresh therefore it was not possible to correlate wind direction and SO₂ records to determine the source of the SO₂ which was responsible for the injury. The proximity of the locations where the injury was observed to the smelters suggests that INCO Metals was responsible for the SO₂ injury at 8 locations while Falconbridge was responsible for SO₂ injury at 5 locations.

In years prior to 1972 acute vegetation injury occurred as far distant as 90 km from Sudbury. During these years vegetation over large areas was sometimes affected and the injury could be usually traced to the offending source. The location of observed SO₂ injury to vegetation in 1971 is included in Figure 18 for comparison with injury observed in 1976 (Figure 19). Vegetation injury over the past few seasons has been confined to relatively small isolated areas and has occurred only on plant species which are sensitive to SO₂.

(b) Vegetation Injury Caused by Other Agents

A total of 113 vegetation samples from the Sudbury area were submitted for pathological examination between 1975 and 1977. The majority of samples were collected in the course of complaint investigations. Only limited numbers of the samples were diagnosed as having been lightly injured by SO₂. The majority of samples showed injury symptoms caused by a number of other agents as indicated in the table below. More than one agent could be involved in single samples.

<u>Causal Agent</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>
SO ₂	4	1	0
Physiological	17	7	2
Deficiency	5	4	0
Insect	14	6	4
Mite	4	0	0
Fungus	24	6	16
Bacteria	3	0	0
Virus	0	3	0
Other	4	6	2
TOTAL SAMPLES EXAMINED	61	28	24

1975

General observations made in the Sudbury area during 1975 showed a severe defoliation of trembling aspen by forest tent caterpillars in late May. Spruce budworm was a severe problem throughout the area on white spruce and balsam fir. Leaf mining insect was a problem in timothy hay in early June. Ink spot (Marssonina) was common on a number of Populus species. Many cultivated mountain ash trees in the city of Sudbury were noted to be severely damaged by Cytospora canker. All of the Northeastern Region was subjected to drought conditions for the greater part of the summer. The effect of this drought was evident as premature leaf coloration primarily on white birch and on trees growing in shallow or sandy soils. Hypoxylon canker was observed to be common on trembling aspen and the white pine blister rust fungus was estimated to have infected 10-15% of white pine trees in the respective areas where these tree species occur.

1976

Observations made on the condition of vegetation during 1976 included road salt injury to vegetation. It was noted that a delay in the emergence of foliage of several deciduous tree species was occurring along major roadways in the Sudbury area. Trees close to the road were severely affected while more distant trees were less affected. A distinct unilateral injury pattern on individual trees was apparent with the most severely injured part of the tree nearest to the road. Lower branches which would have been covered by snow during the winter were less severely injured. The species affected included: white birch, manitoba maple, trembling aspen, mountain ash and elderberry.

Along Highway 69, south of Sudbury, white pine and red pine in the vicinity of the highway exhibited symptoms of severe salt injury which was evident as terminal necrosis of exposed foliage. The damage decreased with distance from the highway.

Insect injury was common although spruce budworm did not appear to be as great a problem as in 1975. Forest tent caterpillars were responsible for light to moderate defoliation of trembling aspen along Highway 69, north of Sudbury. Severe defoliation of balsam poplar in the area north of Val Caron (14 km N of Sudbury) was observed, while trembling aspen in the area between Val Caron and Sudbury were moderately defoliated by tent caterpillars.

Frost injury occurred in the Sudbury Valley area centred approximately 15 km NNW of Sudbury, on the evening of August 1, 1976. Some frost sensitive species were severely injured while other species were less injured. Potatoes, tomatoes, peppers, beans, corn and cucurbits were injured. Approximately 60% of the observed potato crop was affected to some degree but only 10% was severely injured in low areas. A number of ornamental plants were also injured. Injury was reported as far south as Noelville (55 km SE of Sudbury) and as far east as Verner where garden crops and sorghum were injured.

Severe frost injury to vegetation also occurred on the evening of August 29, 1976, in the Sudbury area. Damage to a number of frost-sensitive species not injured by the frost approximately one month earlier, as well as to plants which were recovering from earlier frost injury, was observed. Nearly all potatoes in the Valley area were injured by the later frost.

Hypoxylon canker and Fomes heart rot were observed to be common on trembling aspen and the white pine blister rust fungus continued to be a problem to white pine in the respective areas where these tree species occur. Late plantings of oats and barley in the Verner and Sudbury area were found to be suffering from infection by the barley yellow dwarf virus. Earlier plantings appeared to be less severely affected.

1977

Road salt injury to vegetation was evident in the Spring of 1977. Along Highway 69 between Sudbury and Parry Sound, red pine and white pine were lightly and severely injured respectively. Limited salt injury to hemlock, white cedar and juniper was observed. Moderate salt injury to red and white pine along Highway 17 between Sudbury and Sault Ste. Marie was also observed.

Spruce budworm and tent caterpillars continued to be problems, causing light injury to their host trees north of Highway 17. South of Highway 17, trembling aspen trees, as well as several other species, were severely defoliated by tent caterpillars.

VII SAMPLING AND CHEMICAL ANALYSIS OF VEGETATION AND SOIL
(1970-1976).

a) Program Outline

During the 1970 growing season the Ministry of the Environment established 15 permanent vegetation and soil sampling plots in the territory affected by the Sudbury area smelters and two control plots in areas remote from Sudbury. Since that time, four additional plots were established at various locations. The following table lists the location of each plot, the year of establishment and the distance and direction of the plot from the city of Sudbury. The locations of the sampling sites are shown in Figure 1.

<u>Plot Location</u>	<u>Year Established</u>	<u>Distance and Direction from Sudbury</u>
Blind River	1970	160 km W (Control Plot)
Mattawa	1970	176 km E (Control Plot)
Sudbury	1970	0 km NE
Garson	1970	5 km NE
Skead	1970	26 km NE
Kukagami Lake	1970	42 km NE
Grassy Lake	1970	64 km NE
Timagami	1970	80 km NE
Callum	1970	29 km NE
Sturgeon Falls	1970	77 km E
St. Charles	1970	28 km SE
Burwash	1970	27 km SSE
Tilton Lake	1973	15 km SSW
Lake Penage	1970	37 km SW
Killarney Park	1972	64 km SW
Nairn Centre	1970	48 km WSW
Fairbanks Park	1973	39 km W
Rayside	1970	16 km NW
Morgan	1970	24 km NW
Milnet	1970	37 km N
Chiniguchi Lake	1973	57 km NNE

During 1970, four monthly foliar samples of white birch, trembling aspen, bracken fern, current and one-year old jack pine, grass and soil (0-10 cm) were collected at the 17 area sampling sites. The samples were analyzed for sulphur, copper, nickel, iron, zinc, selenium, arsenic, cobalt and fluoride. Each year the chemical analysis data have been examined and as a result certain modifications have been made in the program. Additional sampling sites have been established, some chemical analyses discontinued, some analyses initiated and the sampling of some plant species discontinued. In 1971, 1972 and 1973, the sampling was carried out during June, July and August. The analysis for fluoride was discontinued in 1971.

In 1974, foliar sampling was reduced to include only trembling aspen and jack pine (current and one-year-old needles) and soil (0-10 cm) which were analyzed for total sulphur, copper, nickel, iron, and arsenic, in June, July and August. In

1975 and 1976, triplicate samples of white birch foliage and triplicate soil samples were collected at each sampling site in July and August. The samples were analyzed for sulphur, copper, nickel, iron, arsenic, and lead in both years.

In years prior to 1975, the analyses were performed on "washed" samples with exception of grass which has always been analyzed on a "not-washed" basis. Experience has shown that the washing procedure did not significantly alter the elemental constituents in vegetation therefore in 1975 and 1976, the chemical analyses were performed on "not-washed" vegetation samples only. All results in this report are reported on a dry weight basis. In addition, the pH of the soil, as well as calcium and magnesium content, has been determined.

b) Excessive Values

The Ontario Ministry of the Environment has conducted numerous vegetation and soil sampling programs throughout the Province of Ontario. Based on experience with these programs as well as on data published in the literature, a set of guidelines has been developed to indicate the concentrations of individual chemical elements which are considered to be excessive in plant tissue and in soil. "Excessive" does not necessarily mean toxic, but is evidence of contamination above average normal levels. The excessive levels of contaminants in vegetation or soil are considered to be tools for use by phytotoxicology investigators in interpreting the results of chemical analyses. Certain limitations exist with these established levels and investigators must judge their use in supplementing other results and observations from field assessment surveys. The following values are used in this report:

<u>Element</u>	<u>Concentrations Considered Excessive (ug/g)</u>	
	<u>Vegetation</u>	<u>Soil</u>
Arsenic	8	25
Cobalt	10	25
Copper	30	100
Fluorine	35	-
Iron	800	-
Lead	50	200
Nickel	30	100
Selenium	3	5
Zinc	250	400

c) Elemental Analysis of Vegetation

Sulphur:

Sulphur content measurements of vegetation foliage samples collected in the Sudbury study area are shown in Tables 9 to 13. The maximum sulphur concentration recorded was 0.50% S in trembling aspen foliage at Skead in 1971.

Sulphur concentrations in the samples were consistently highest at Garson and Skead for all plant species. Slightly lower values were reported for collections made at Sudbury, Milnet, Kukagami, Callum, Burwash and Rayside while at the more remote stations, sulphur concentrations were similar to those of the control samples. Jack pine foliage contained lower concentrations of sulphur as compared with the other species.

Mean sulphur concentrations were computed from data obtained each year for each plant species at the original fifteen sampling locations, exclusive of the control locations. This information is presented in Figure 21. The highest sulphur concentrations were recorded in 1971 and decreased in each following year. Values for 1971 were elevated over those of 1970 mainly as a result of the high concentrations reported for the month of August. The values for June and July, 1971 were generally similar to the values obtained in 1970, however there was a tendency for sulphur concentrations in the samples to increase over the season. No single factor can be demonstrated as the cause of the higher sulphur measurements in 1971. Falconbridge SO₂ emissions for 1971 were greater than in 1970, but the reverse was true for Inco SO₂ emissions. Average hourly SO₂ readings in the growing season were higher at Skead and Kukagami in 1971 than in 1970 however the hourly SO₂ readings at Grassy, Burwash and Rayside decreased. Readings at the remaining locations were similar in each year. Total potentially injurious fumigations were similar for each year (Table 8). The numbers of fumigations with intensities greater than 75 increased at Garson, Skead, Kukagami, and Morgan in 1971; however, the numbers decreased at Grassy, Penage, Burwash, Rayside, St. Charles, and Callum in 1971 over 1970. Other factors which influence uptake of SO₂ by plant foliage may also have been responsible for the observed increase in sulphur content of the samples in 1971. However, even if 1971 is regarded to an abnormal year, sulphur values have declined in the following years in comparison with the 1970 values, with the exception of bracken fern.

Nickel:

The concentrations of nickel measured in samples collected at the sampling sites from 1970 to 1975 are included in Tables 14 to 18.

Nickel concentrations greater than 30 ug/g tissue are considered to be excessive.

White birch foliage samples from sites nearest to the smelters (Sudbury, Garson and Skead) contained the highest amounts of nickel ranging from 58 to 133 ug/g Ni (Table 14). Slightly more remote stations such as Rayside, Callum, Burwash, Tilton Lake and Kukagami had slightly less elevated nickel concentrations which ranged from 16 to 78 ug/g Ni. The remaining stations within the Sudbury area all contained higher concentrations of nickel (8 to 42 ug/g Ni) as compared with samples collected at the control locations (3 to 9 ug/g Ni). There was no pattern of shift in nickel content of the white birch foliage over the sampling period.

Nickel concentrations in trembling aspen foliage (Table 15) tended to be higher than for any other plant species foliage samples. Excessive nickel concentrations were consistently measured at Sudbury, Garson, Skead, Kukagami, Callum, Burwash, Tilton Lake, Rayside, Milnet, Chiniguchi and Fairbanks Lake (30 to 136 ug/g Ni). Excessive nickel concentrations were measured at Lake Penage in two years (1973 and 1974).

Samples collected at Sturgeon Falls, Temagami, Killarney and Nairn Centre contained slightly elevated concentrations of nickel in comparison with control location samples.

Excessive nickel concentrations were measured in samples of jack pine foliage collected at Sudbury, Skead, Kukagami, Milnet, Callum and Rayside. No jack pine samples were available at Garson. The remainder of the samples collected in the Sudbury area contained elevated nickel concentrations in comparison with samples collected at the control sites. Slightly lower concentrations of nickel were found in one-year-old foliage than in current-year foliage. This demonstrates that accumulation of nickel in the foliage of this species with time was not occurring.

Variability in nickel concentrations in bracken fern foliage from year to year was observed, however, samples from stations nearest to the smelters usually contained the highest nickel concentrations. Excessive nickel concentrations were measured in one or more years at Sudbury, Garson, Kukagami, Callum, Burwash and Rayside.

Nickel concentrations were also variable in grass foliage samples. Excessive amounts of nickel were measured in one or more years at Sudbury, Garson, Skead, Callum, Milnet, Rayside, Morgan, Kukagami and Tilton Lake. With the exception of samples collected at Grassy Lake, Temagami and Sturgeon Falls, the nickel content of samples from the remaining stations was elevated in comparison with samples from the control locations.

Copper:

The concentrations of copper measured in vegetation samples collected in the Sudbury area are presented in Tables 19 to 23. Copper concentrations greater than 30 ug Cu/g tissue are considered to be excessive.

Excessive copper concentrations were found in white birch foliage in three years at Garson, two years at Skead and one year at the Kukagami and Sudbury sites. Other stations showed copper values to be generally greater than those of the controls and to decrease with distance from the smelters. Excessive copper concentrations were measured only in trembling aspen at Skead in 1970. Excessive amounts of copper were measured in jack pine foliage at Skead, Kukagami, Milnet and Rayside in 1970, at Sudbury in 1972 and at Skead in 1974. Grass foliage samples contained excessive amounts of copper at Garson (1970, 1972) and Skead (1970, 1974). Excessive copper concentrations were not measured in bracken fern. Garson, Skead and Sudbury sites consistently contained the greatest amounts of copper while concentrations of copper in the samples decreased with distance from the smelters for all plants species.

Iron:

Iron concentrations in foliage samples are shown in Tables 24 to 28. In this report, iron concentrations of greater than 800 ug Fe/g tissue are considered to be excessive.

There was considerable variation in iron content among sampling locations. Only one sample (white birch, 1975) from Temagami contained excessive amounts of iron. The higher iron concentration in this sample could be attributed to the iron deposits in the Temagami area. Measured concentrations of iron in control samples were lower than in samples collected nearer to the smelters, possibly related to uptake of iron from the soil and the soil type itself.

Arsenic:

Arsenic concentrations measured in the vegetation samples collected in the Sudbury area are reported in Tables 29 to 33. For purposes of this report, concentrations greater than 8 ug As/g tissue are considered to be excessive.

The highest arsenic values were consistently found at Garson and Skead for all plant species. Only two samples (white birch foliage, 1975, and jack pine foliage, 1971) from Skead were found to contain excessive concentrations of arsenic. In general, the samples of vegetation collected nearer to the smelters had a higher arsenic content than samples collected at the control locations.

Selenium:

The selenium concentrations measured in the vegetation samples are included in Tables 34 to 38. Concentrations in excess of 3 ug Se/g foliage are considered to be excessive.

No samples were found to contain excessive amounts of selenium. Three samples contained more than 1 ug Se/g. These were white birch at Garson in 1970 and trembling aspen at Garson and Skead, also in 1970.

Zinc:

The concentrations of zinc measured in the vegetation samples are reported in Tables 39 to 43. The zinc content varied from year to year and site to site, however, there was no indication that higher zinc concentrations were present at sites nearer to the smelters. Higher zinc concentrations were measured in white birch and trembling aspen foliage than in the other species since these two tree species are known to accumulate zinc, consequently the excessive value criteria cannot be applied to these two species. The excessive concentration value of 250 ug Zn/g tissue was not exceeded in any sample of the other plant species.

Lead:

The concentrations of lead measured in vegetation samples collected in the Sudbury area are presented in Table 44. Values reported were low for all samples and there was no difference between concentrations measured at the control locations and at samples collected nearer to the smelters.

No sample of any species contained excessive concentrations of lead (50 ug/g tissue).

Cobalt:

Cobalt concentrations measured in vegetation samples are included in Tables 45 to 49. In this report, cobalt concentrations in vegetation greater than 10 ug/g are considered to be excessive.

The majority of samples contained similar amounts of cobalt to those in the control samples. Values reported for 1971 tended to be slightly higher than those for other years. Samples of trembling aspen from Sudbury, Kukagami, Grassy Lake, Callum and St. Charles in 1971 contained cobalt in concentrations greater than 10 ug/g tissue. Cobalt concentrations in jack pine foliage and grass foliage were generally lower than those in white birch, trembling aspen and bracken fern.

Fluoride:

Fluoride concentrations in all vegetation samples collected in 1970 were very low and did not approach the concentration considered to be excessive (35 ug F/g) (Table 50). For this reason, samples of vegetation collected after 1970 were not analyzed for fluoride.

d) Elemental Analysis of Soil

Sulphur:

Sulphur concentrations measured in soil samples are presented in Table 51. Only two samples, both collected at Skead, contained sulphur concentrations greater than 0.10%. The remainder of the samples contained sulphur in amounts similar to or slightly greater than control samples.

Nickel:

Values for nickel concentrations reported for soil samples are presented in Table 52. Nickel concentrations greater than 100 ug Ni/g soil are considered to be excessive.

The highest values were obtained at Sudbury, Garson and Skead; the sites nearest to the smelters. Two collections at Rayside and individual samples from Callum and Tilton Lake contained excessive amounts of nickel. Except for the more remote sample locations of Killarney and Sturgeon Falls, the soil samples contained nickel in concentrations higher than at control locations.

Copper:

The concentrations of copper measured in the soil samples are shown in Table 53. Copper concentrations greater than 100 ug/g soil are considered excessive.

Copper values were highest at the Sudbury site, with Garson and Skead soils containing slightly lower amounts of copper. Some samples of soil from Kukagami Lake, Callum, Tilton Lake and Rayside also contained excessive amounts of copper. Soil samples from most sampling locations in the Sudbury study area contained copper in amounts considerably greater than did control soils.

Iron:

Iron concentrations in the soil samples are reported in Table 54. The values are quite variable among stations from year to year and station to station. No pattern in soil iron concentrations in relation to smelter location was evident.

Arsenic:

The reported concentrations of arsenic in soil samples are presented in Table 55. An arsenic concentration greater than 25 ug/g soil is considered to be excessive.

Only three samples of soil, from Skead (1971, 1972) and Garson (1971) contained excessive arsenic concentrations. Elevated arsenic values were reported from Sudbury, Kukagami, Grassy, Callum and Rayside in one or more years. Soil samples from the remaining locations contained arsenic in concentrations similar to or slightly greater than those of the control samples.

Selenium:

Selenium concentrations in soil were reported for only two years; 1970 and 1972 (Table 56). Only two soil samples (Sudbury, 1972; Garson, 1970) contained selenium in concentrations greater than 1.0 ug Se/g soil, but these were below the concentration considered to be excessive (5.0 ug/g soil). Selenium concentrations in the remainder of the samples fell within the range of selenium concentrations reported for the control samples.

Zinc:

Concentrations of zinc measured in soil samples collected in the Sudbury area are presented in Table 57. No sample contained zinc in amounts considered to be excessive (400 ug Zn/g soil). Most soil samples contained zinc concentrations similar to those of control samples, however, some samples contained elevated concentrations of zinc (Grassy, Sturgeon Falls, St. Charles, Penage).

Lead:

Lead concentrations in soil samples are reported in Table 53. No sample contained excessive amounts of lead (200 ug Pb/g soil). Most soil samples in the Sudbury area contained lead in concentrations similar to or slightly greater than the concentrations present in the control samples, however, some samples from Skead, Grassy, Penage and Nairn contained elevated lead concentrations.

Cobalt:

The concentrations of cobalt measured in soil samples are reported in Table 59. Cobalt concentrations greater than 25 ug Co/g soil are considered to be excessive.

No soil sample contained excessive amounts of cobalt. All reported cobalt concentrations, except for some samples collected at Milnet, Grassy, Callum and Fairbanks Lake, fell within the range of cobalt concentrations measured in the control samples. There was no apparent relationship between cobalt in soil and location of the smelters.

Fluoride:

Fluoride concentrations measured in the soil are presented in Table 50. The amounts of fluoride present in the samples collected in the Sudbury area never exceed the amounts present in the control samples. Fluoride is usually present in soil in amounts between 100-300 ug F/g soil, however, it is bound in the soil and is not taken up by plant roots, consequently fluoride in soil rarely constitutes an environmental problem.

Calcium And Magnesium:

The concentrations of calcium and magnesium measured in the soil samples collected in the Sudbury area are presented in Tables 60 and 61 respectively. No excessive values have been established for these elements.

Considerable variability in concentrations of both of these elements was observed between both stations and years. Magnesium values in general were higher than calcium values. The overall values for both elements are considered to be low, particularly for calcium. Calcium concentrations measured in soils collected in 1973 at Chiniguchi, Skead, Tilton Lake and Fairbanks Lake are considered to be extremely low.

Since calcium and magnesium are the principal components which provide buffering capacity for a soil, it would be expected that the low concentration of these elements measured in the samples would result in reduced pH values of the soils. The pH values are low for all soils in the study area (Table 62). Considerable variation in pH values exists from collection to collection, with the majority of samples having pH values in the range of pH 4.0 to 5.5.

e) Summary of Results of Vegetation & Soil Sampling Program

Excessive concentrations of nickel and copper were frequently found in soils and vegetation samples collected at Sudbury, Garson and Skead. Excessive concentrations of these two metals were also found in some samples collected at slightly greater distances from the smelters (Rayside, Tilton Lake, Callum and Kukagami Lake). Most soil samples collected in the Sudbury study area contained elevated copper concentrations in relation to the control samples. A decline in the average concentration of sulphur in vegetation samples collected in the Sudbury area was observed in the period after 1972.

A limited number of vegetation samples contained excessive levels of arsenic or selenium and again these samples were collected in close proximity to the smelters. Lead, zinc and fluoride concentrations were within normal limits for the respective plant species.

At Skead and Garson, three soil samples contained excessive amounts of arsenic. Soil samples from Sudbury (1972) and Garson (1970) contained the highest concentrations of selenium but these were not considered to be excessive. Iron, zinc, lead, cobalt and fluoride concentrations in soil were not excessive, however some values for these elements were elevated in relation to control sample values. Calcium and magnesium values for the soil samples were low and were considered to be related to low soil pH values.

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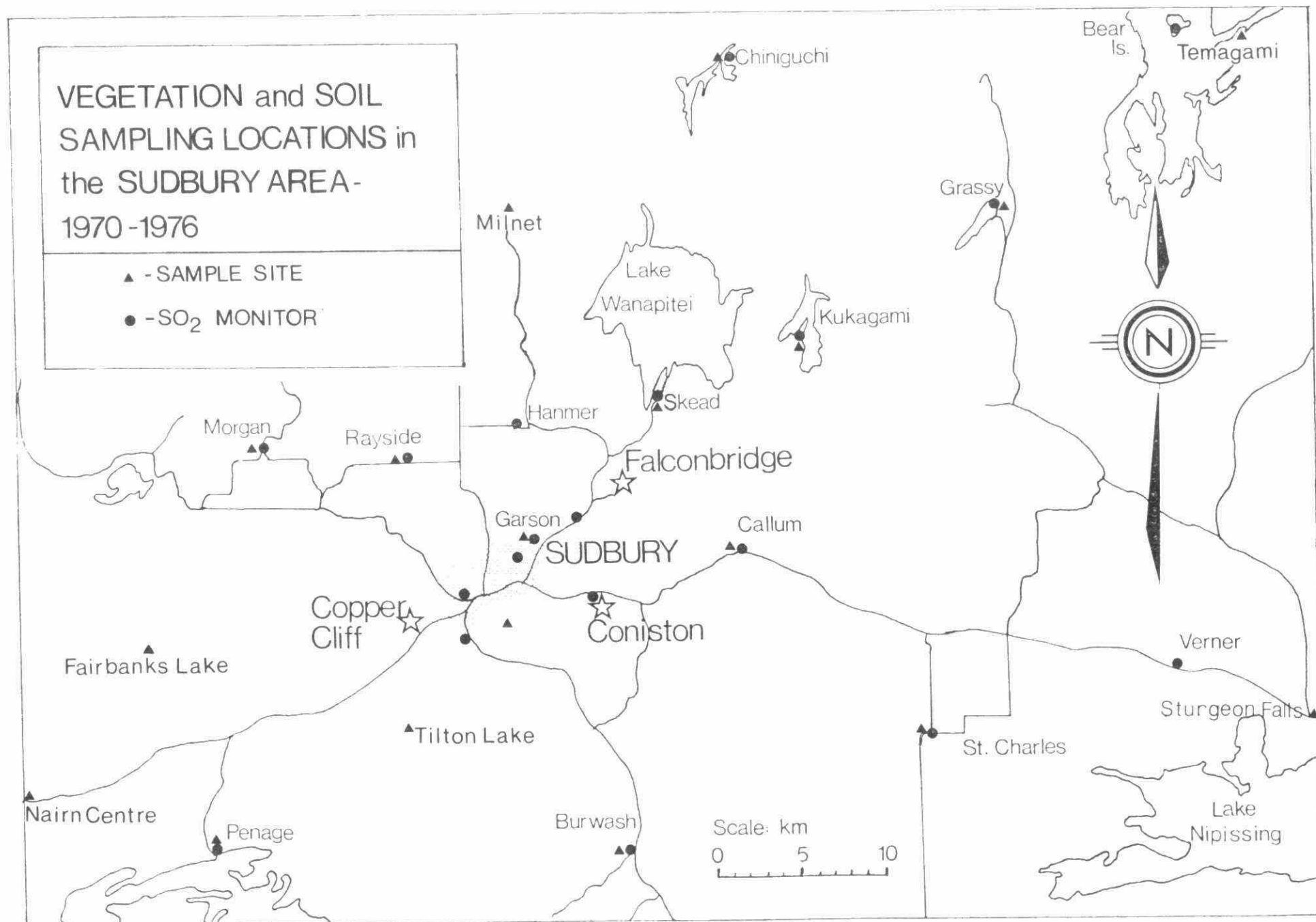
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X APPENDIX

Figure 1:



SO₂ EMISSIONS (10⁶ TONS)

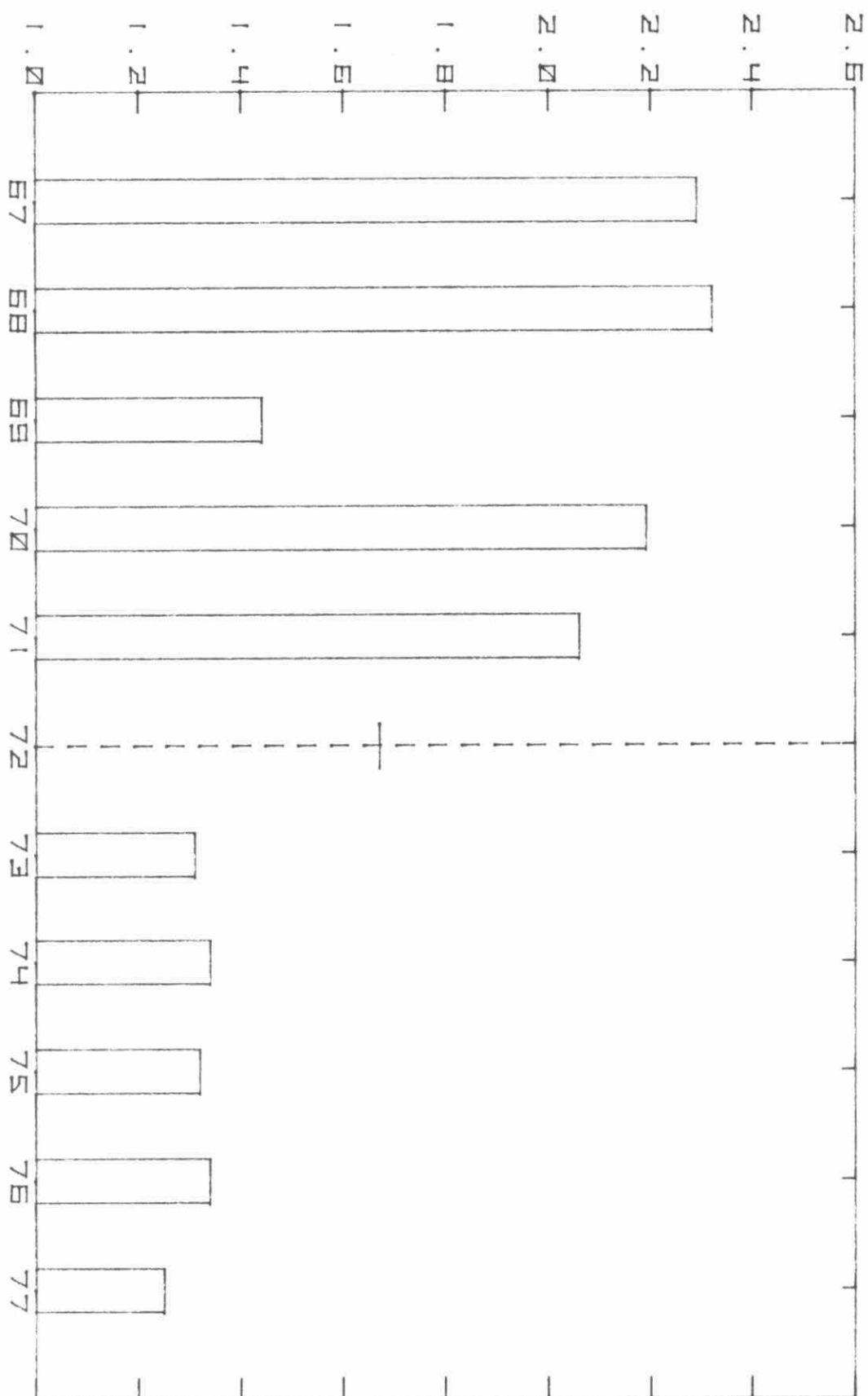


FIG. 2 ANNUAL SO₂ EMISSIONS FROM INCO OPERATIONS
(VALUES RELEASED BY THE INCO METALS CO.)

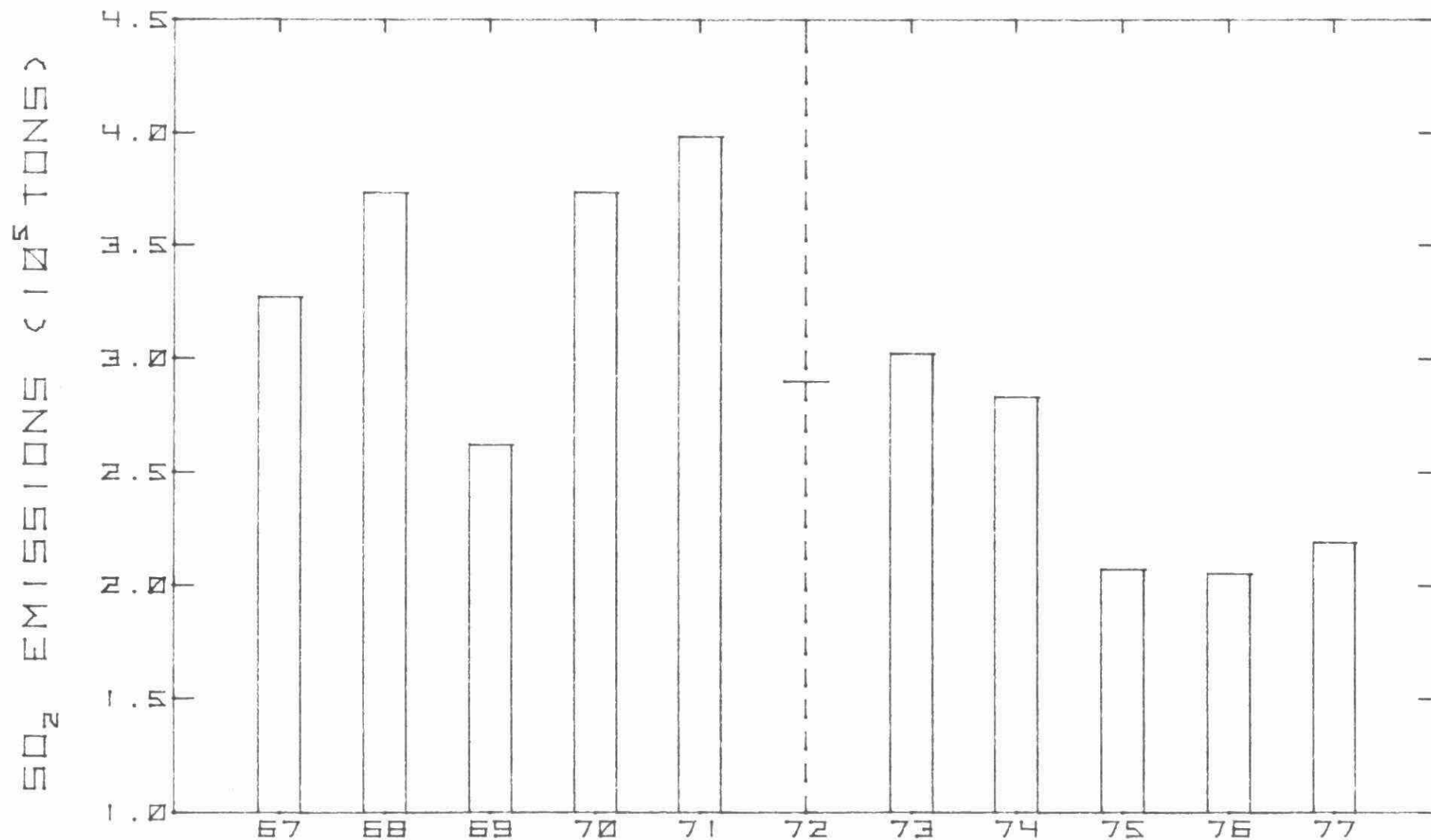


FIG. 3 ANNUAL SO₂ EMISSIONS FROM FALCONBRIDGE OPERATIONS
(VALUES RELEASED BY FALCONBRIDGE NICKEL MINES)

Figure 4:

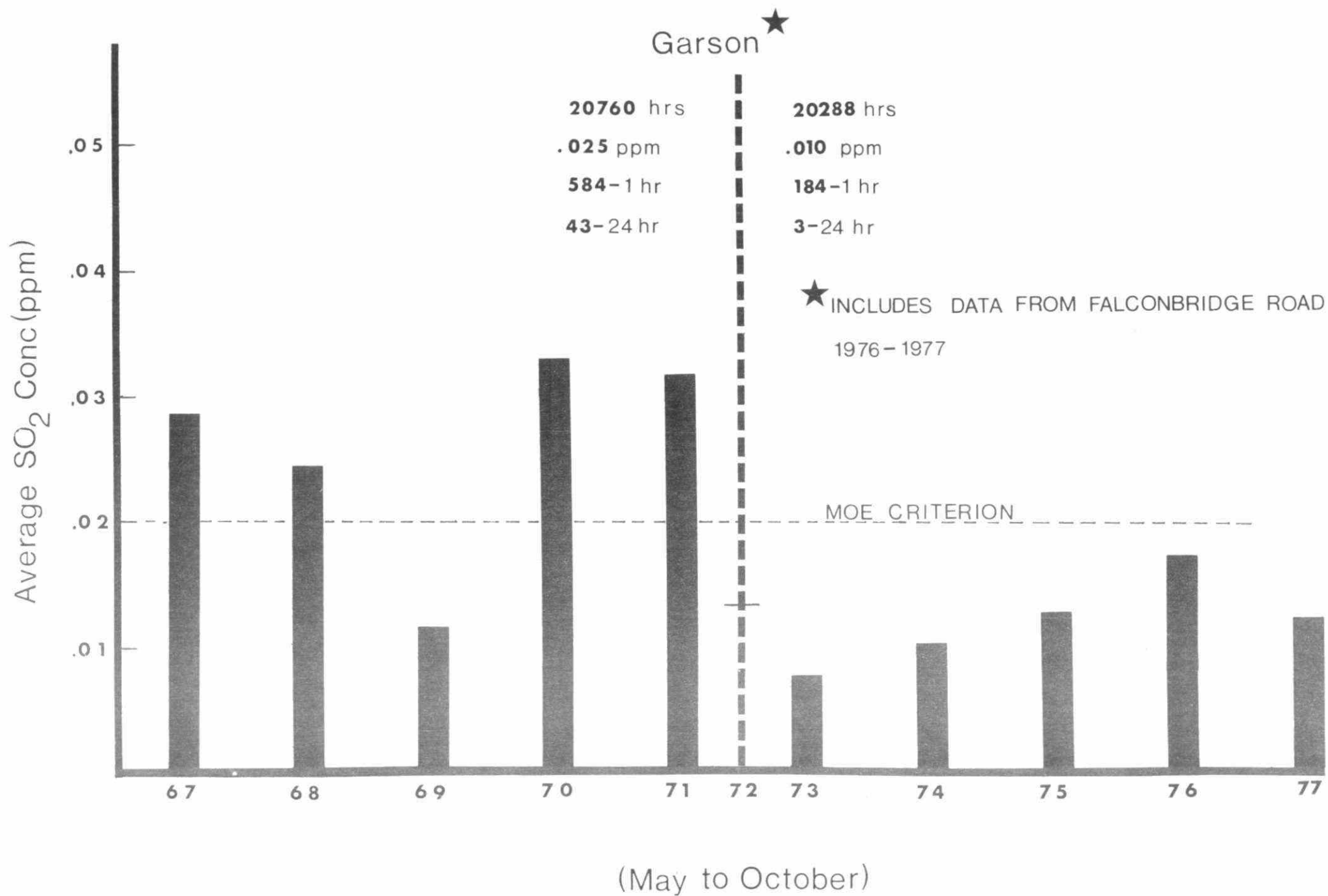


Figure 5:

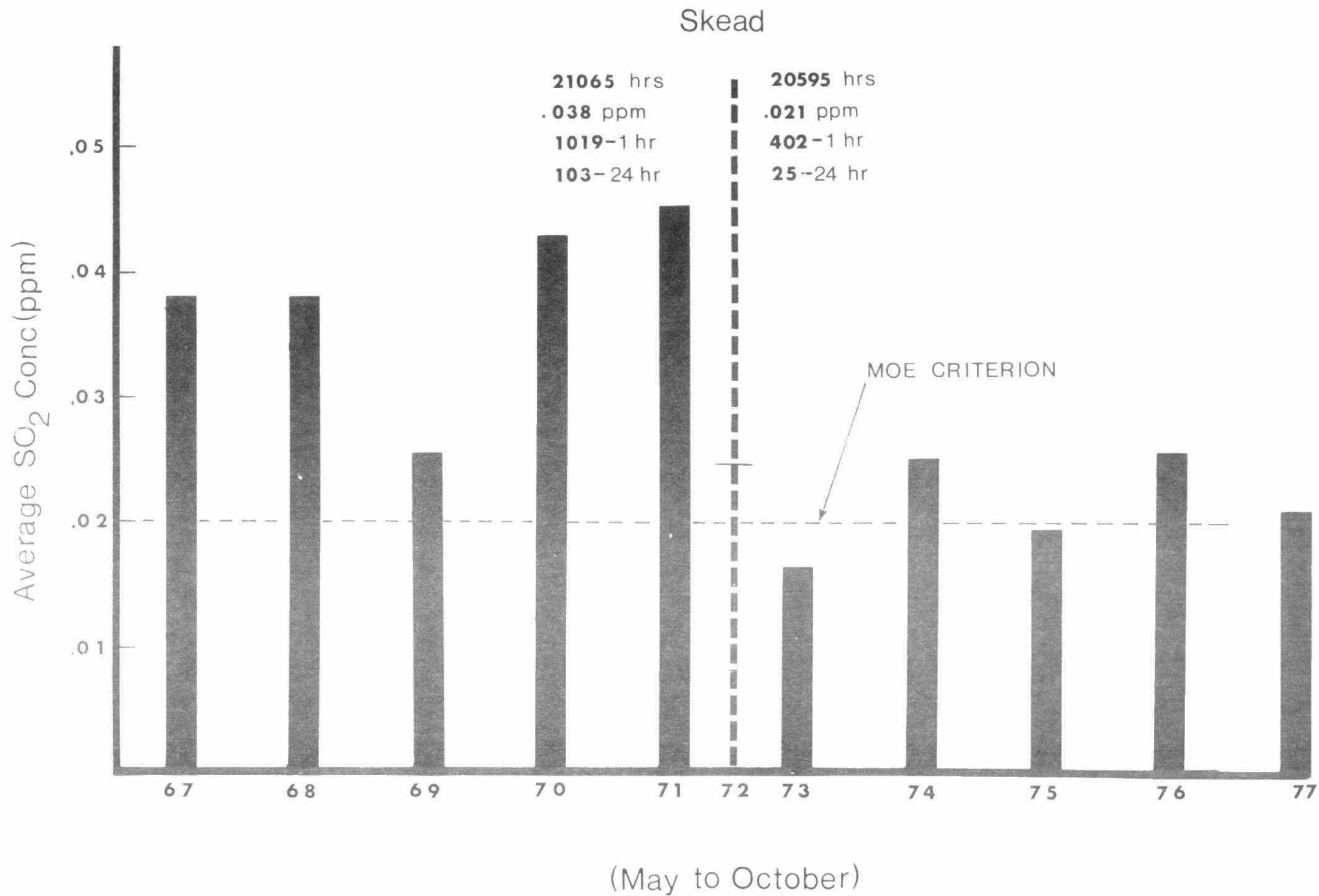


Figure 6:

Rayside

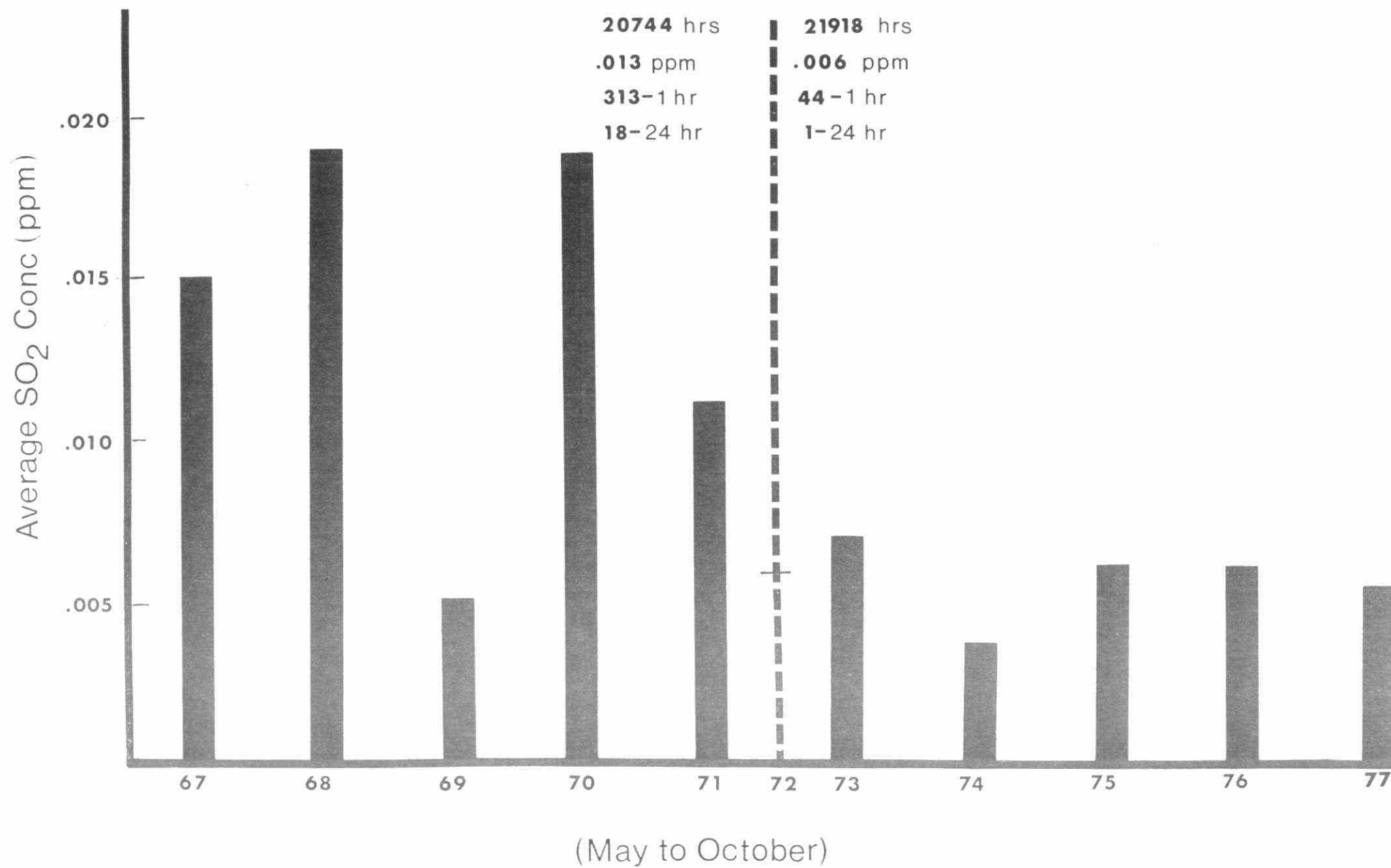


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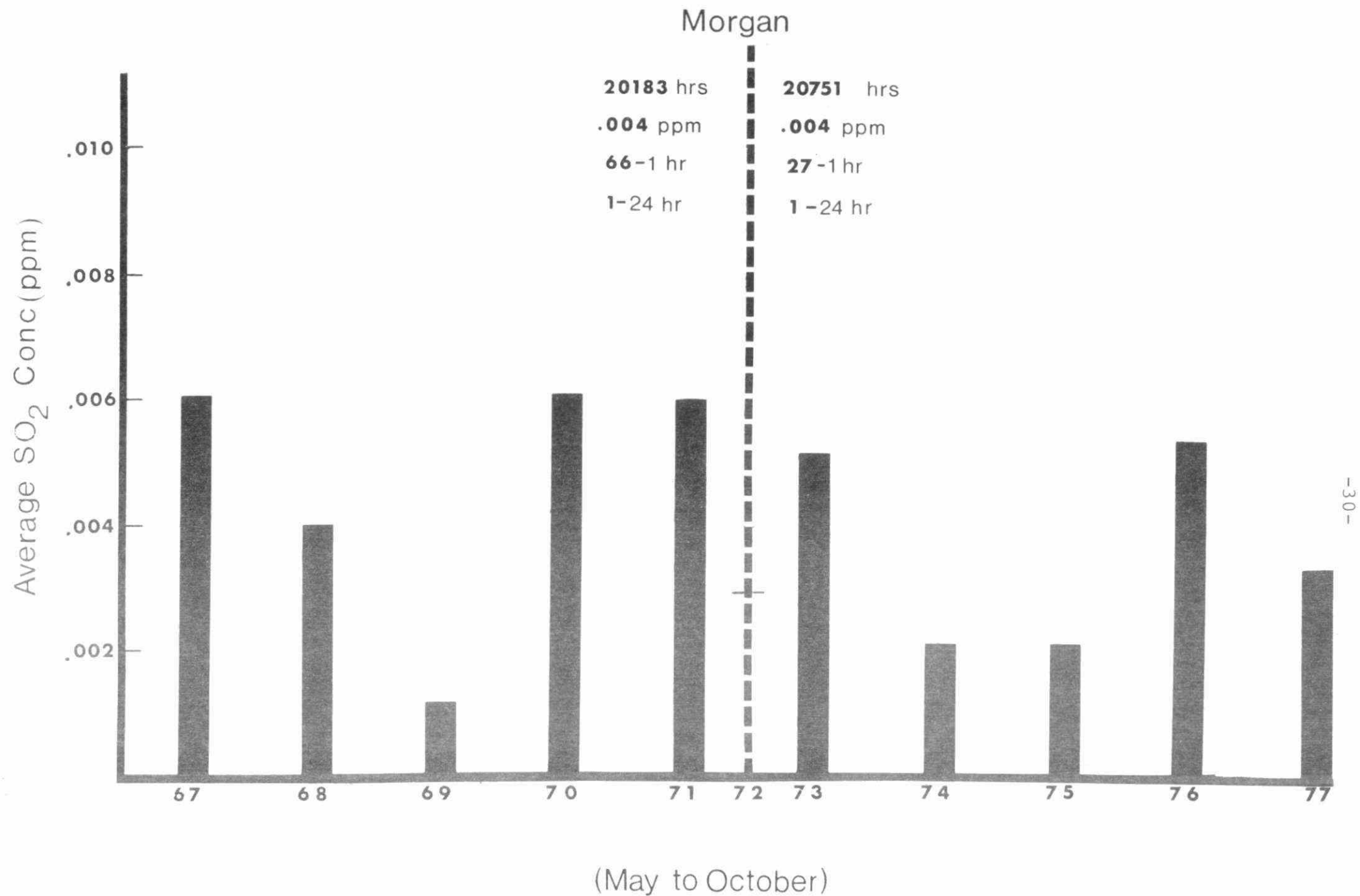


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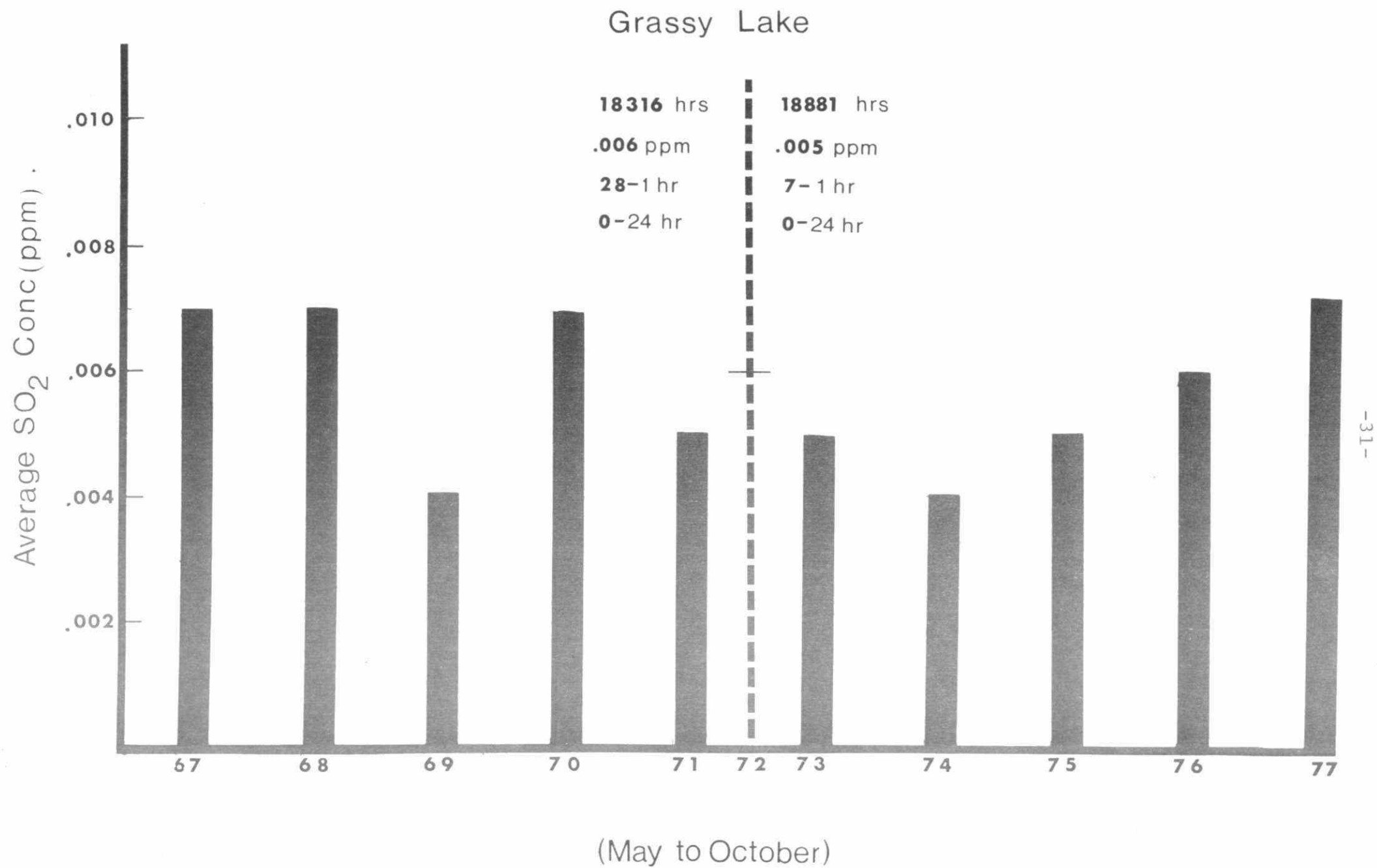


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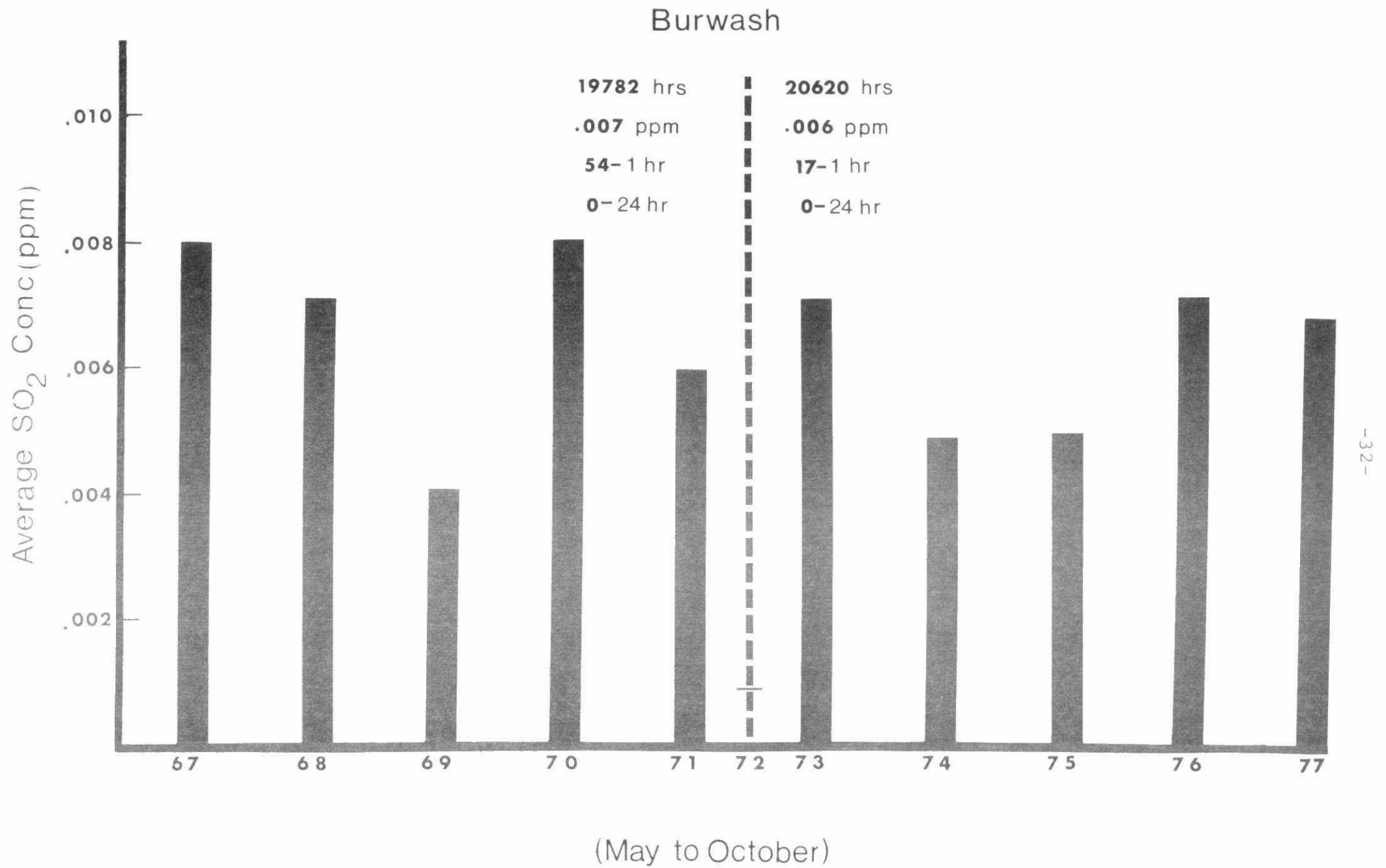


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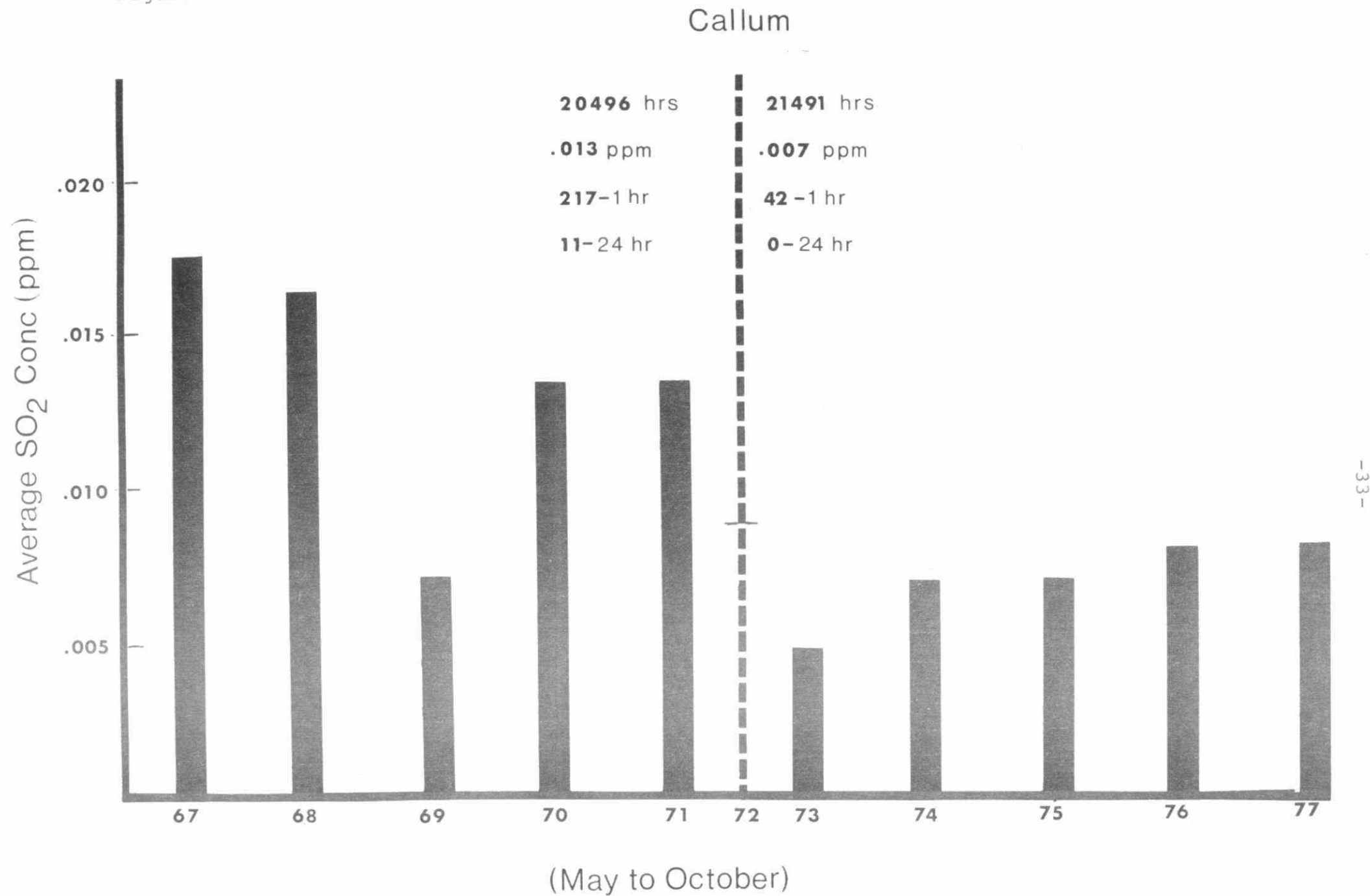


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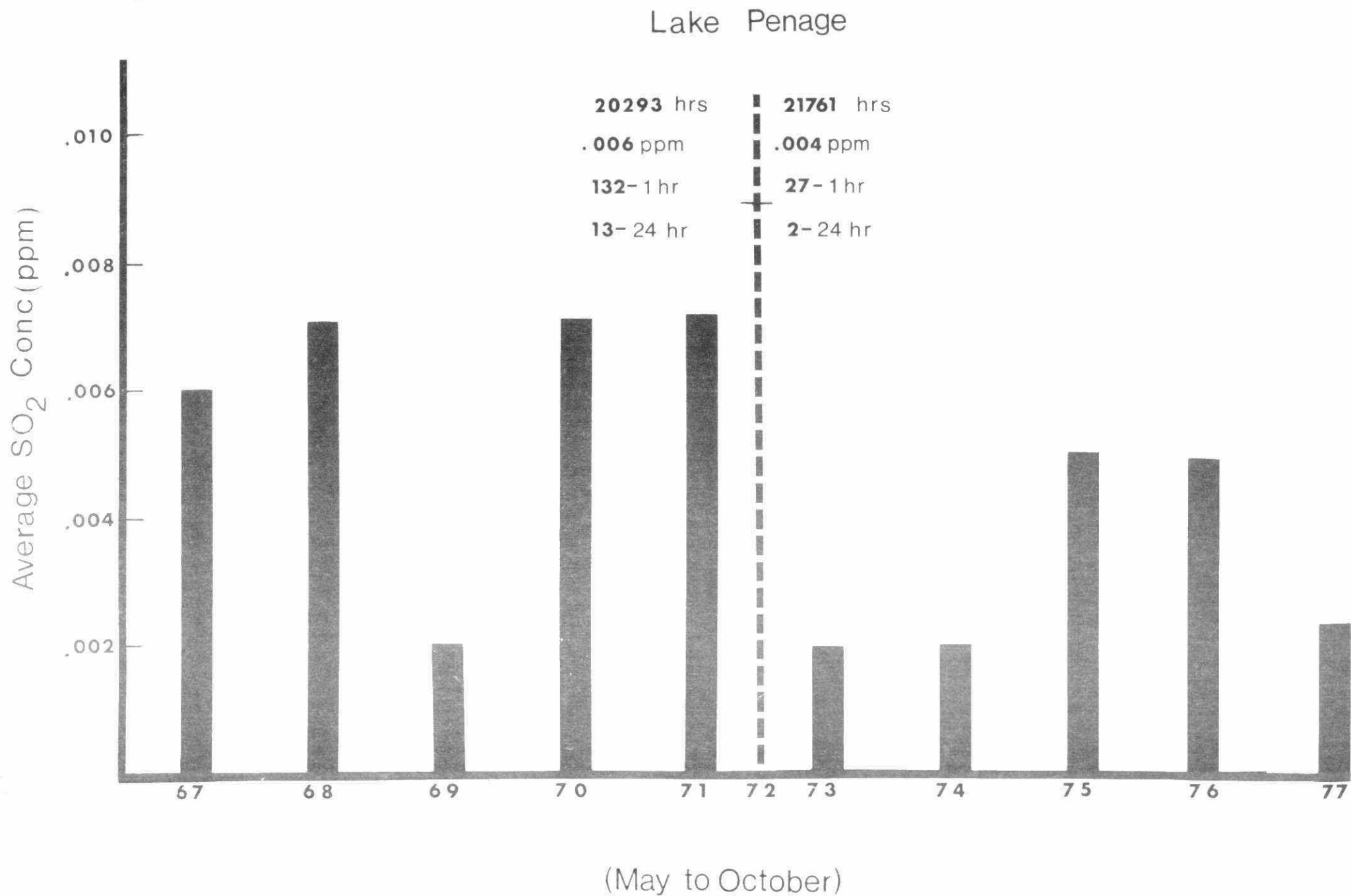


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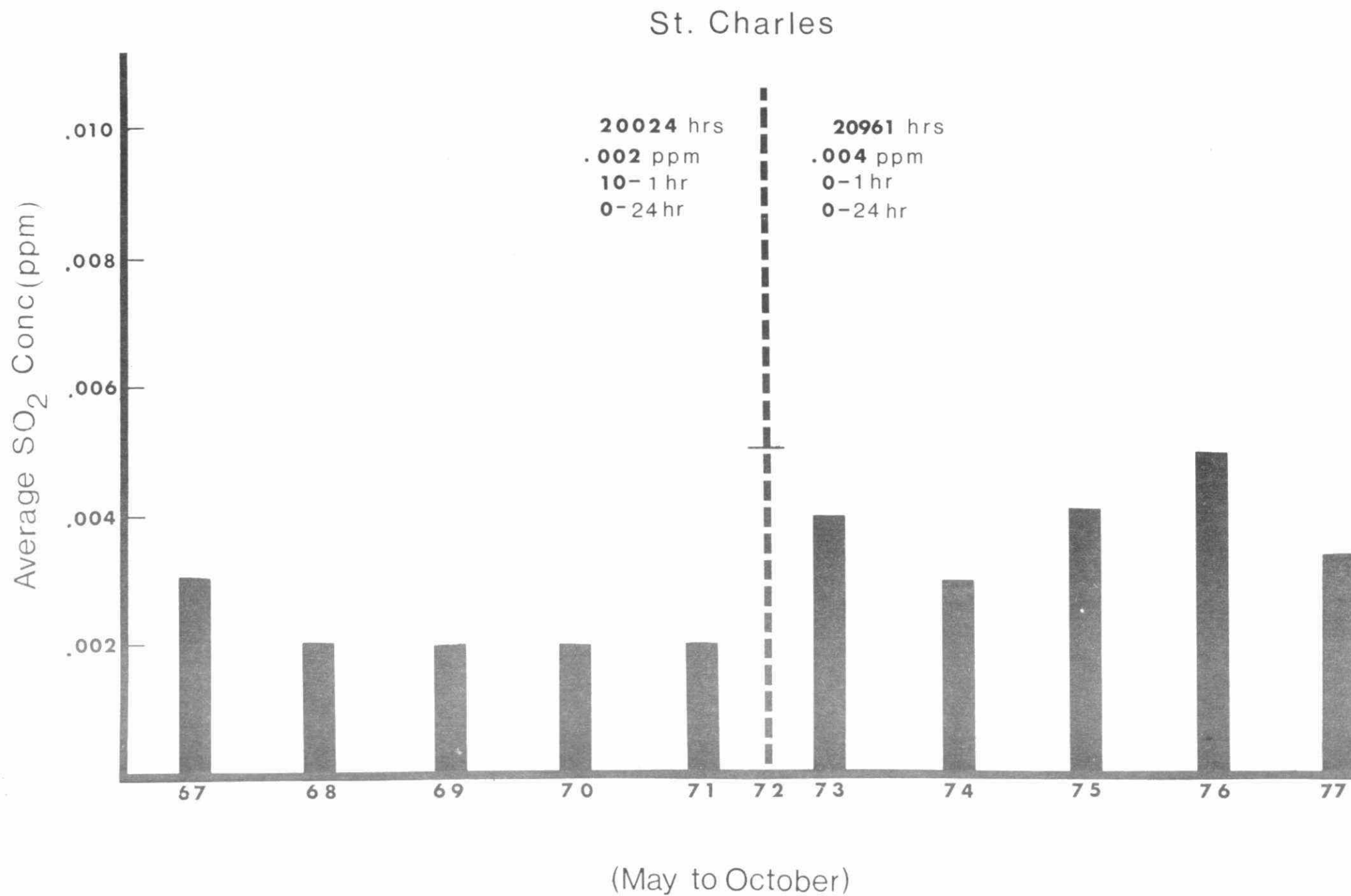


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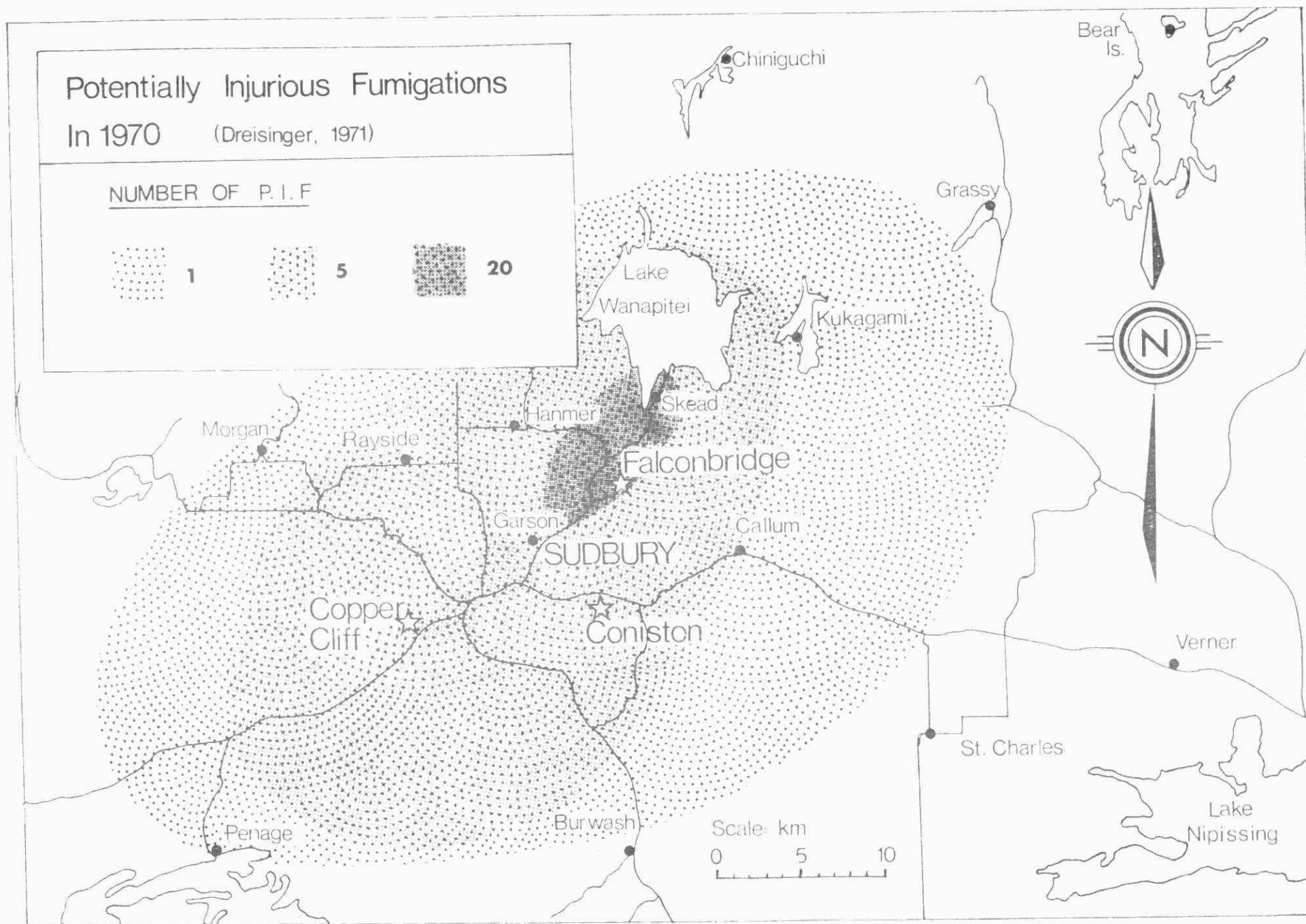


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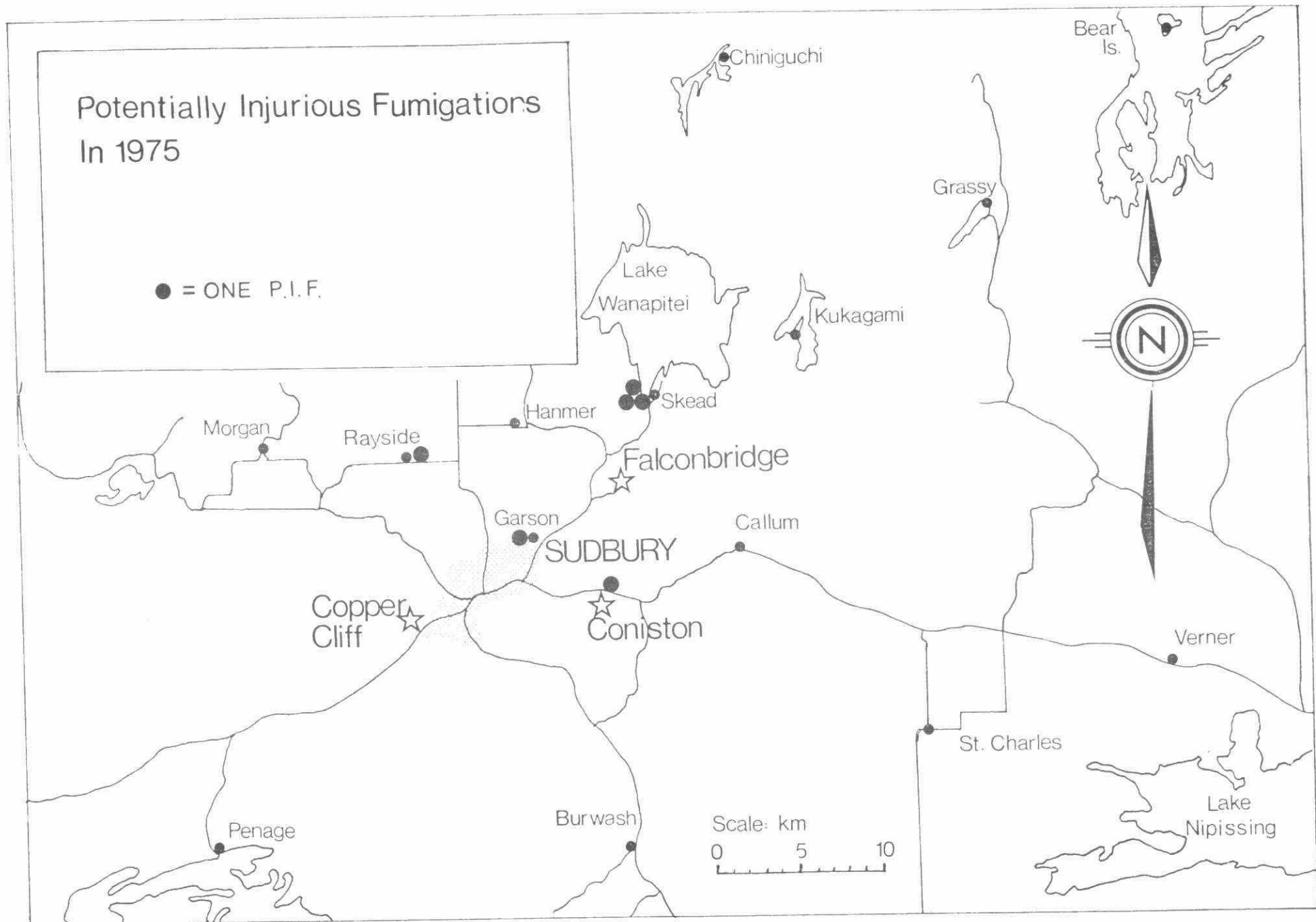


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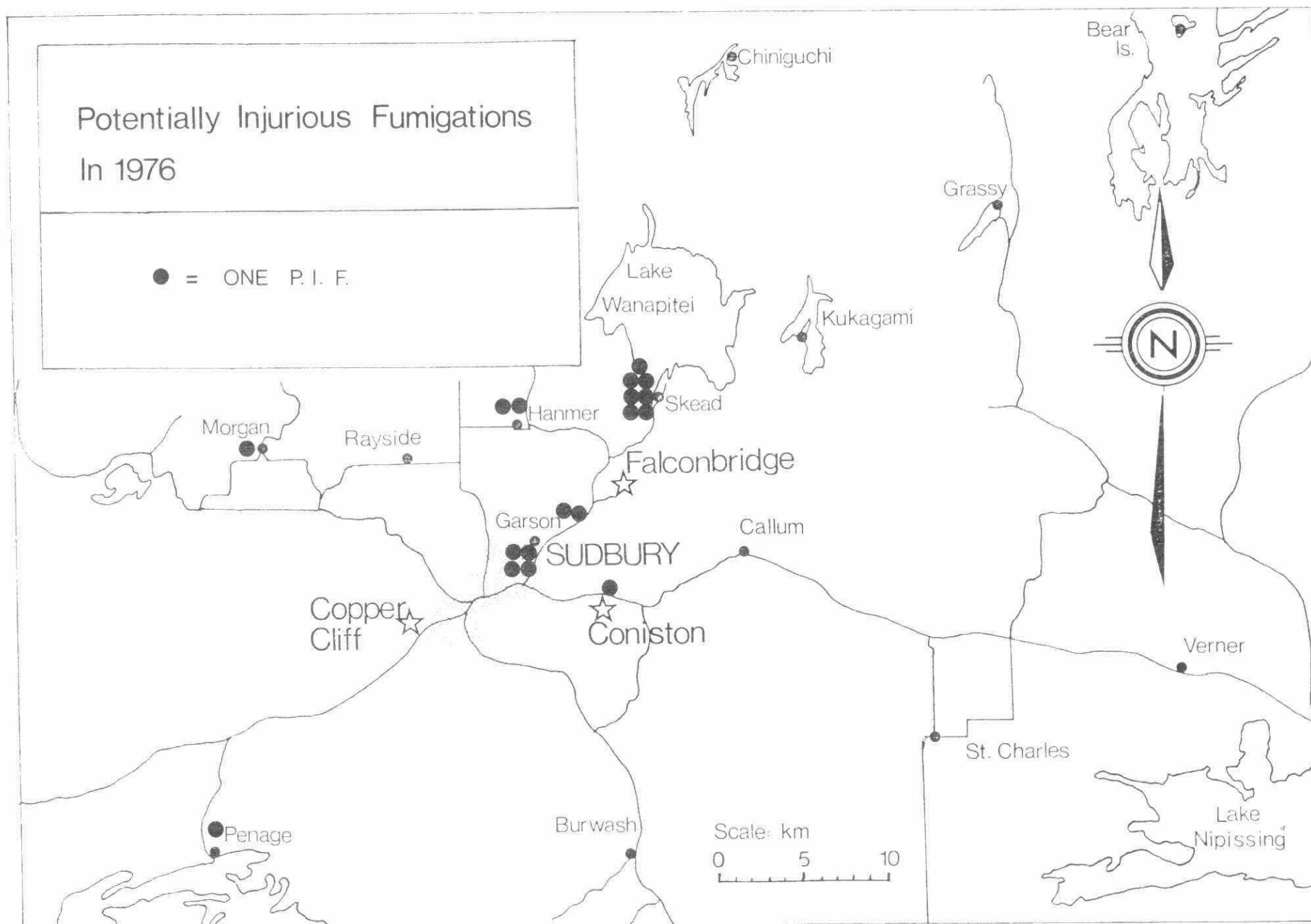


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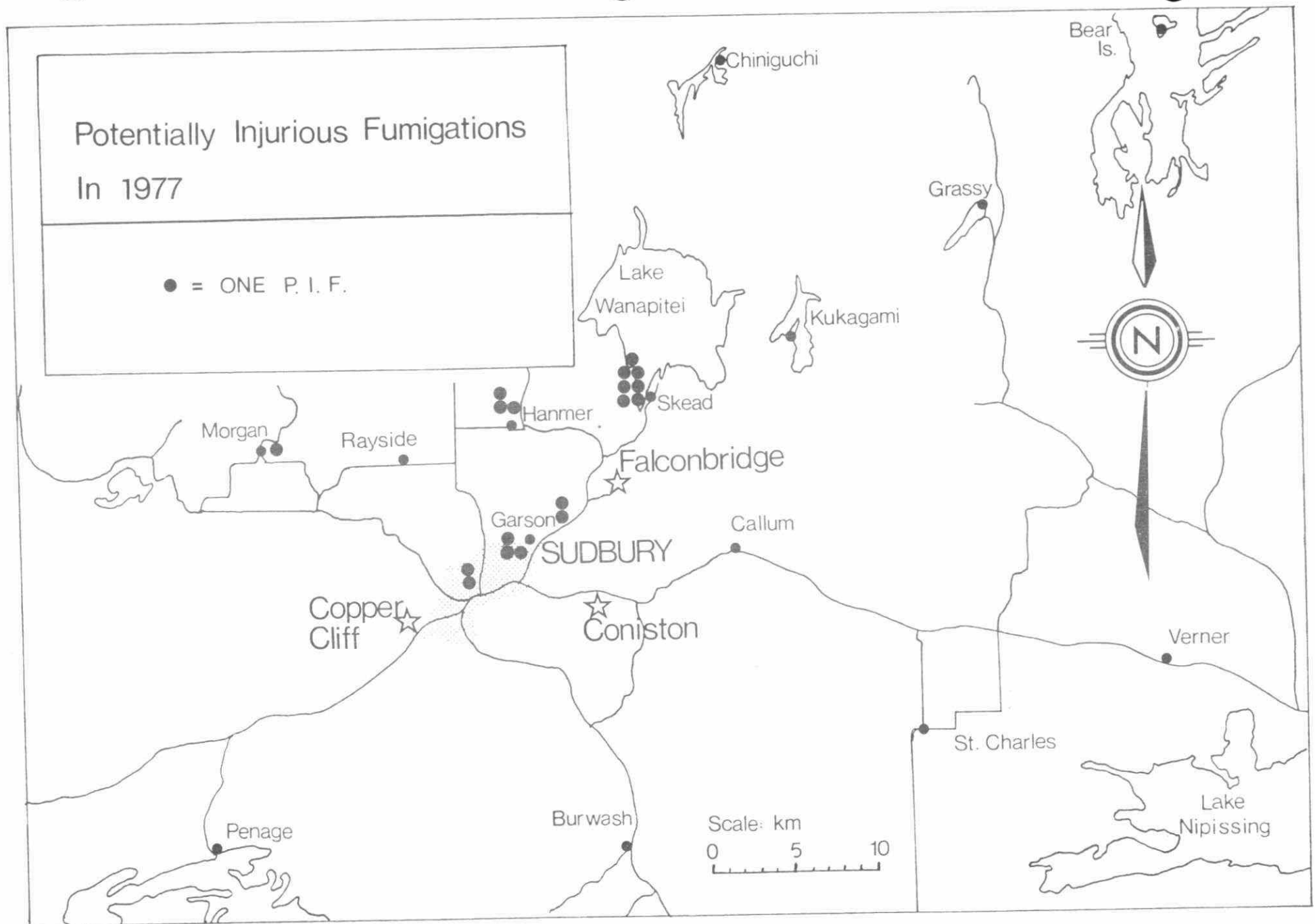


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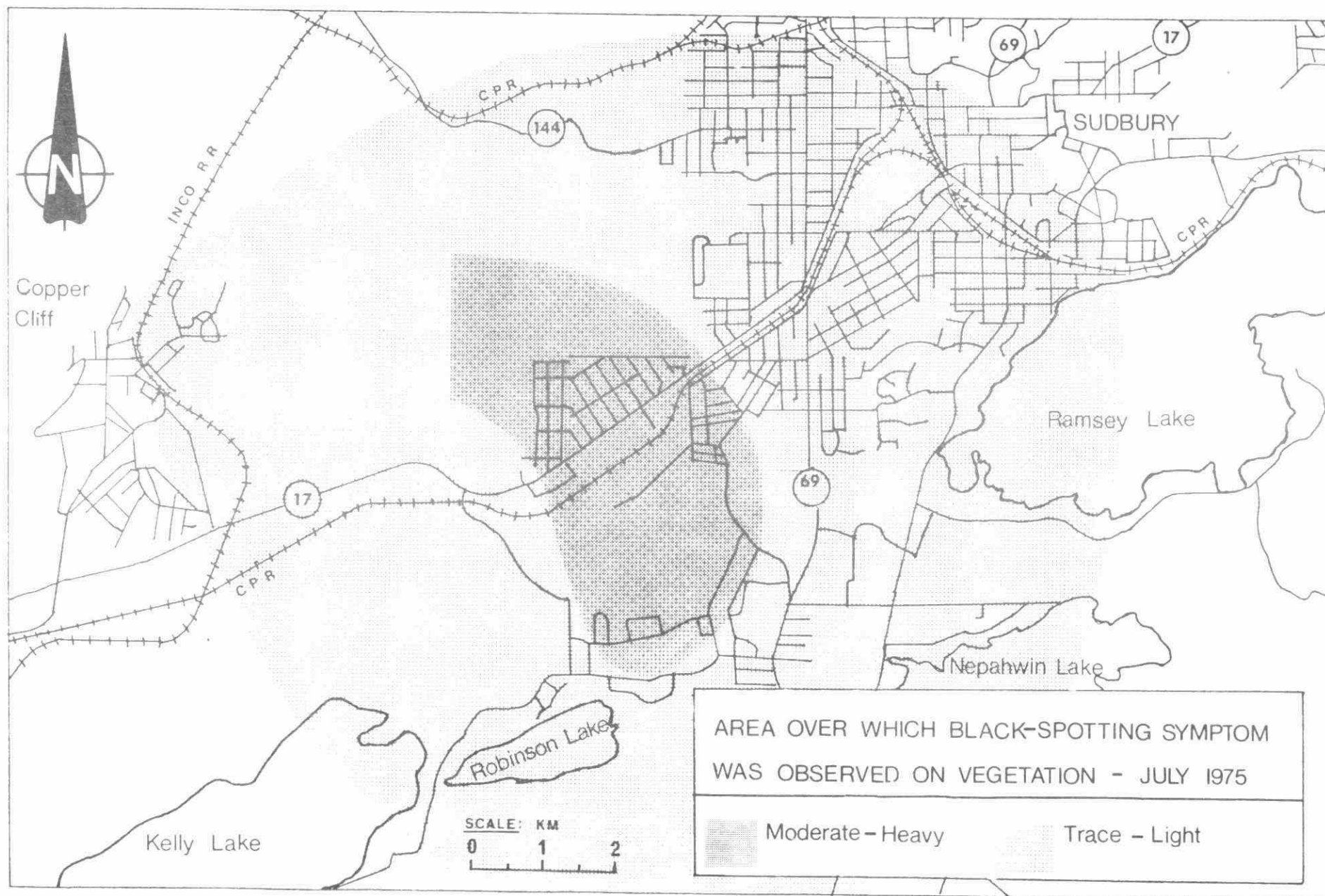


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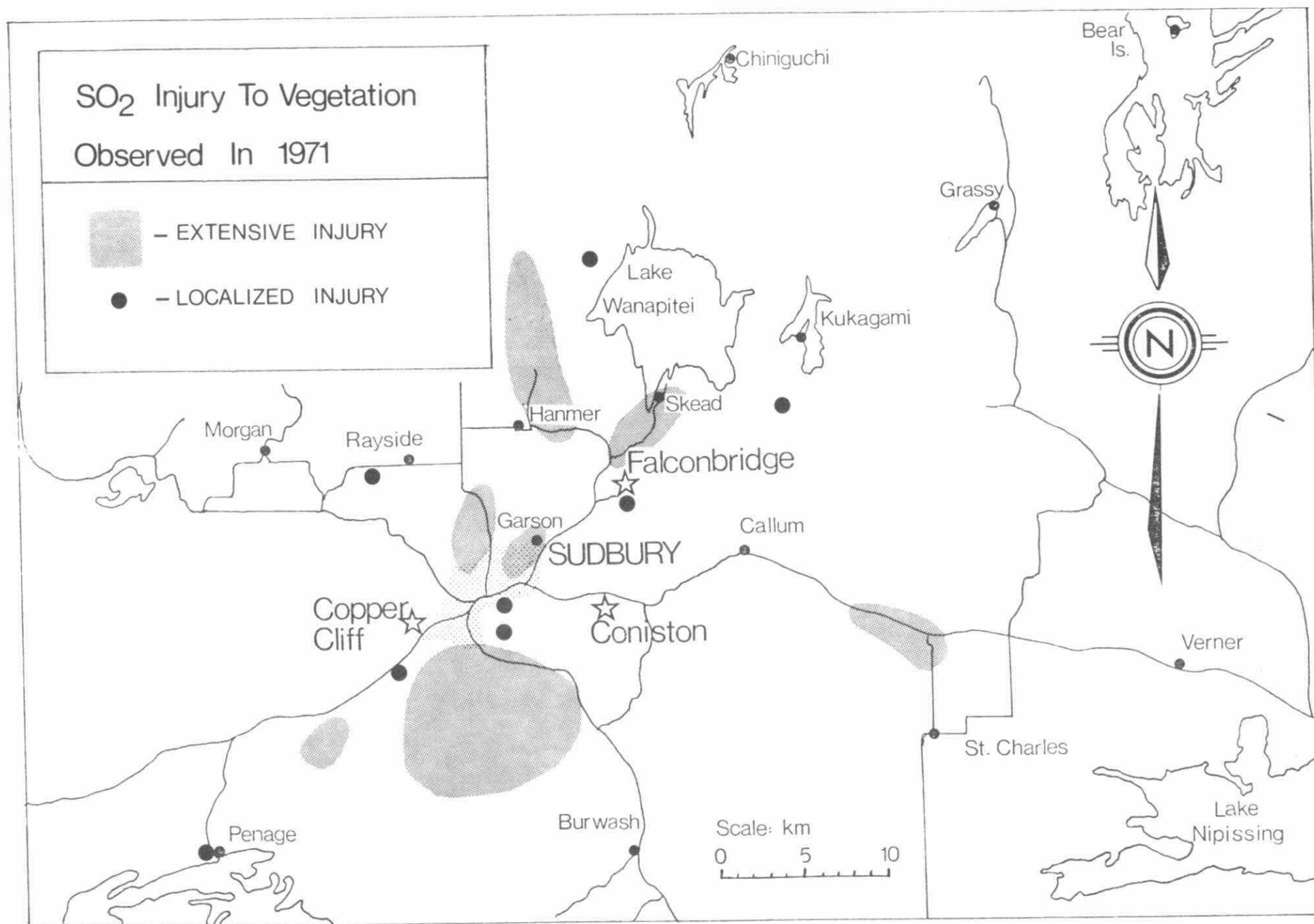
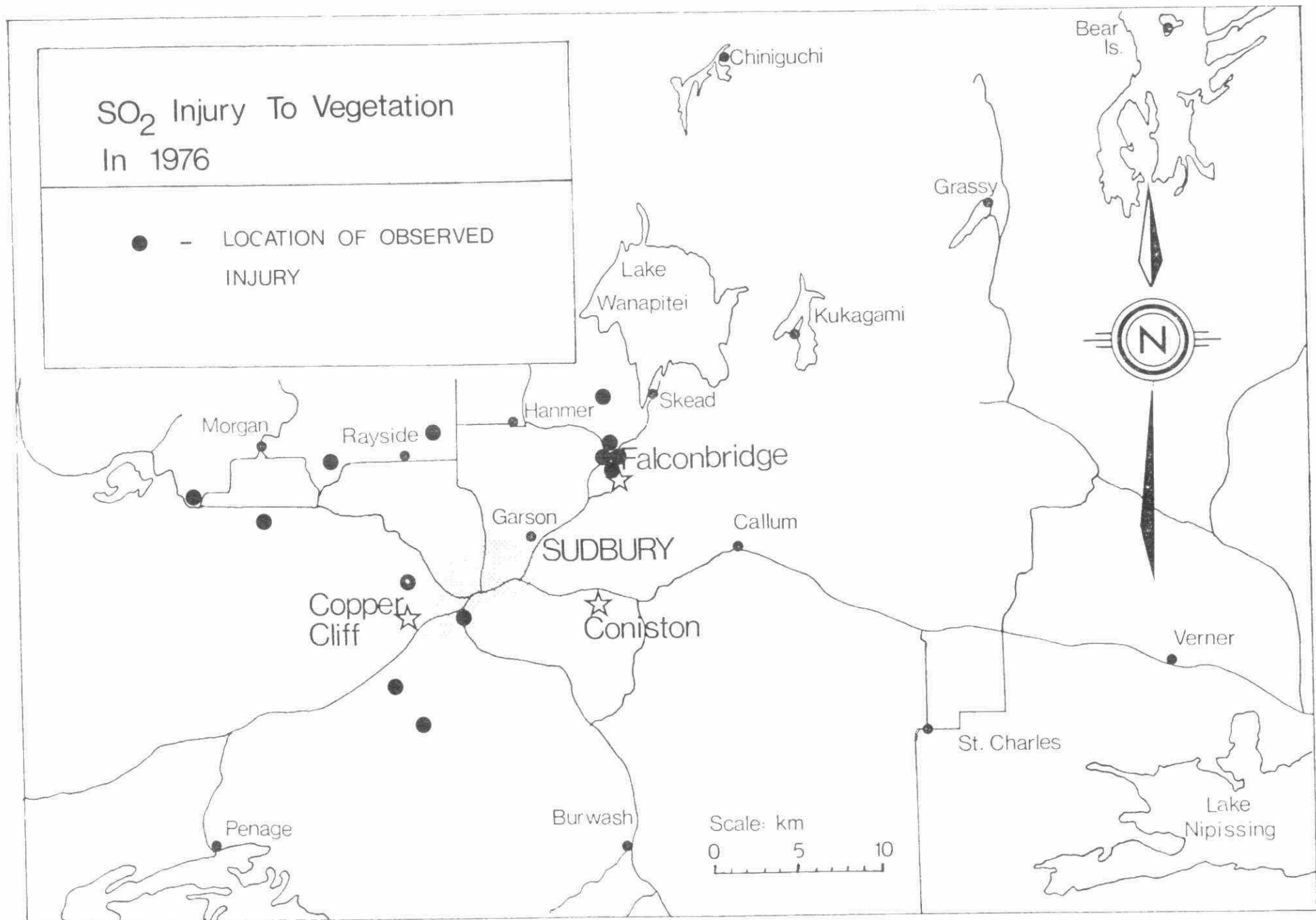


Figure 19:



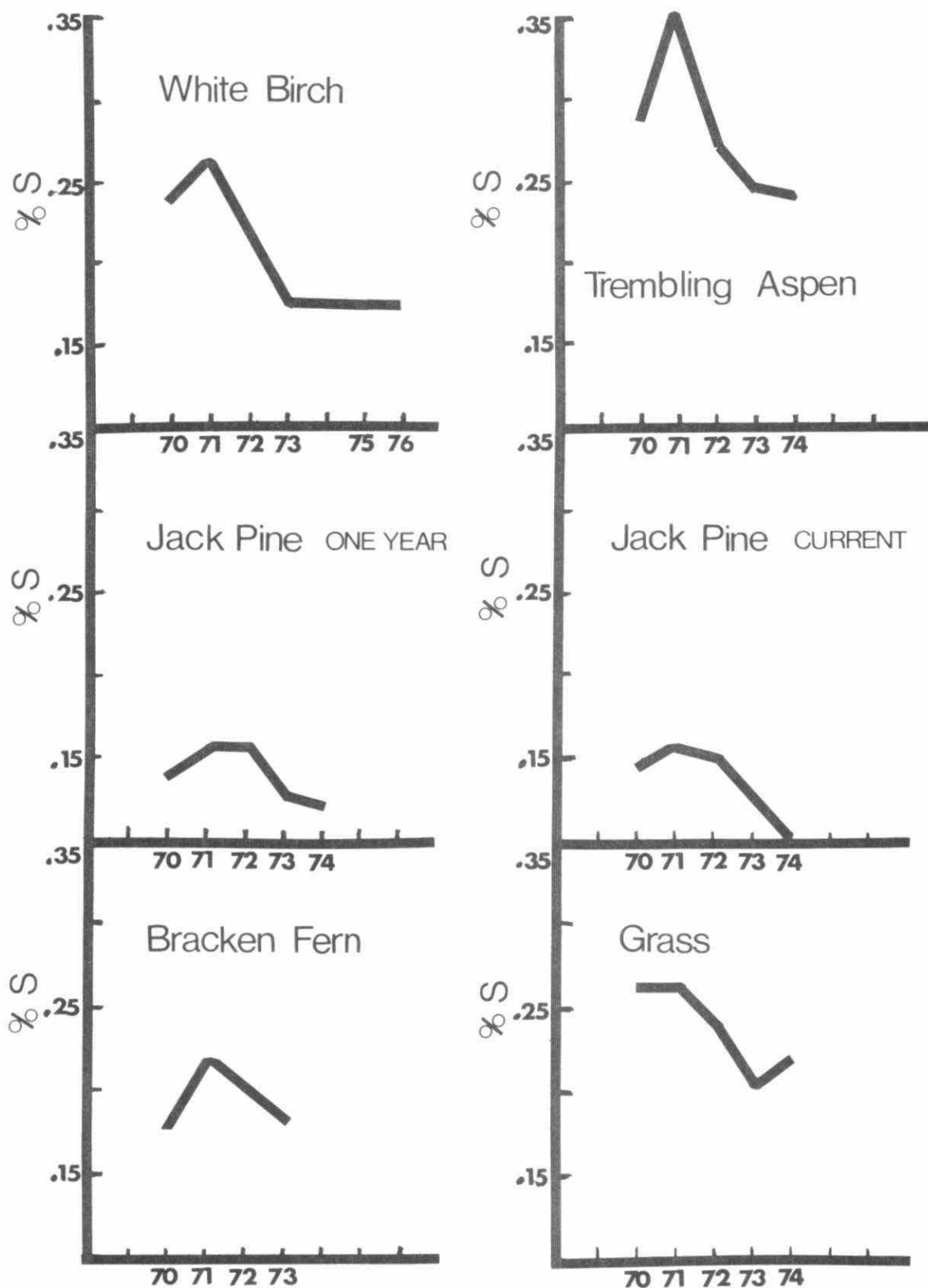
SULPHUR IN VEGETATION IN THE SUDBURY
AREA

TABLE 1:

SUMMARY OF THE SO₂ MONITORING DATA FOR THE
SUDBURY AREA FROM MAY TO OCTOBER-1975

<u>Station</u>	<u>Operative Days</u> (<u>May to October</u>)	<u>Distribution of SO₂ Hourly Readings</u>					<u>Max. 1 Hr.</u> <u>Conc. (ppm)</u>	<u>Date</u>
		<u>0.0-0.04</u>	<u>.05-.25</u>	<u>.25+</u>	<u>.50+</u>	<u>1.0+</u>		
Ash St. (Sudbury)	179	3739	458	16	1	0	.56	Sept. 9
Lockerby	128	2923	97	24	3	0	.66	Aug. 19
Coniston	175	3946	198	23	0	0	.43	June 1
Lake Penage	181	4235	89	11	1	0	.67	June 29
Burwash	184	4303	86	5	0	0	.37	Sept. 27
Callum	182	4232	133	8	0	0	.41	Aug. 28
Skead	169	3705	313	59	15	4	1.75	Sept. 20
Hanmer	171	3938	116	18	1	0	.56	Sept. 3
Rayside	181	4231	103	7	3	1	1.00	Aug. 23
Garson	162	3794	177	52	6	1	1.05	Aug. 16
Morgan	178	4238	29	2	0	0	.33	Oct. 12
St. Charles	176	4163	54	1	0	0	.25	Aug. 7
Grassy Lake	151	3511	93	0	0	0	.21	July 1
Verner	177	4207	28	1	0	0	.28	Sept. 14
Chiniguchi Lake*	81	1944	36	1	0	0	.26	Sept. 3
Lake Temagami**	133	3121	69	0	0	0	.11	Aug. 13
	<u>2,608</u>	<u>60,230</u>	<u>2,079</u>	<u>228</u>	<u>30</u>	<u>6</u>		

* July to October only. Total Hours 62,537

** June to October only.

SUMMARY OF THE SO₂ MONITORING DATA FOR THE
SUDBURY AREA FROM MAY TO OCTOBER-1976

<u>Station</u>	<u>Operative Days</u> (May to October)	<u>Distribution of SO₂ Hourly Readings</u>					<u>Max. 1 Hr.</u> <u>Conc. (ppm)</u>	<u>Date</u>
		<u>0.0-0.04</u>	<u>.05-.25</u>	<u>.25+</u>	<u>.50+</u>	<u>1.0+</u>		
Ash St. (Sudbury)	178	3766	432	33	3	0	.69	June 5
New Sudbury	174	3712	398	46	14	0	.96	Oct. 3
Coniston	181	3891	322	36	2	0	.61	Sept. 6
Lockerby	160	3662	141	18	2	0	.66	May 12
Lake Penage	183	4298	80	6	0	0	.47	Sept. 17
Burwash	177	4086	180	3	0	0	.27	Oct. 16
Callum	180	4188	142	9	0	0	.38	May 26
Skead	176	3727	371	92	36	7	1.72	May 5
Hanmer	172	3959	150	26	3	0	.74	June 13
Rayside	182	4280	85	9	2	0	.65	June 18
Garson*	38	868	33	7	0	0	.46	May 30
Falconbridge Road**	133	2992	209	38	7	0	.97	Aug. 20
Morgan	177	4180	53	11	4	0	.86	Sept. 21
St. Charles	180	4287	50	1	0	0	.25	May 14
Grassy Lake	123	2837	133	4	0	0	.34	June 27
Verner	148	3542	29	0	0	0	.14	Sept. 12
Chiniguchi Lake***	104	2387	132	1	0	0	.27	June 23
Lake Temagami	152	3611	93	1	0	0	.27	June 23
Total	2,818	64,273	3,033	341	73	7		

* Operation during May & June only

** June to October Data only Total Hours 67647

*** May to September Data only

TABLE 3:

SUMMARY OF THE SO₂ MONITORING DATA FOR THE
SUDBURY AREA FROM MAY TO OCTOBER-1977

Station	Operative Days (May to October)	Distribution of SO ₂ Hourly Readings					Max. 1 Hr. Conc. (ppm)	Date
		0.0-0.04	.05-.25	.25+	.50+	1.0+		
Ash St. (Sudbury)	184	3944	310	16	2	0	.72	May 30
New Sudbury	177	3737	408	42	6	1	1.19	June 11
Coniston	184	3984	284	35	7	0	.70	May 12
Lockerby	177	4009	173	16	2	0	.69	May 7
Lake Penage	183	4343	49	5	1	0	.57	Aug. 30
Burwash	175	4073	129	3	1	0	.56	Oct. 17
Callum	183	4182	188	11	1	0	.54	June 3
Skead	178	3875	308	111	33	3	1.28	July 12
Hanmer	168	3887	139	38	7	0	.73	Sept. 9
Rayside	178	4217	81	8	1	0	.60	Sept. 8
Falconbridge Road	164	3706	232	35	3	0	.87	June 13
Morgan	179	4243	41	8	2	1	1.45	Oct. 29
St. Charles	181	4282	70	0	0	0	.19	Aug. 20
Grassy Lake	160	3739	115	0	0	0	.23	July 19
Verner	181	4334	40	0	0	0	.15	May 19
Chiniguchi Lake	135	3084	168	4	1	0	.52	May 31
Lake Temagami	147	3533	61	0	0	0	.14	July 19
Total	2,934	67,172	2,796	332	67	5		

Total Hours 70300

Potentially Injurious Fumigations Recorded by Sudbury
Area SO₂ Monitors During the 1975 Growing Season

<u>Station</u>	<u>Number of P.I.F.</u>	<u>Date</u>	<u>Intensity</u>
Ash Street	0	(Aug. 16)*	(74)
Lockerby	1	Sept. 9	105
Garson	3	July 1	106
	-	Aug. 9	111
	-	Aug. 16	199
Skead	3	July 6	156
	-	July 7	114
	-	Sept. 20	223
Chiniguchi Lake	0	(Sept. 17)	(48)
Grassy Lake	0	(July 1)	(37)
Lake Temagami	0	(Aug. 16)	(27)
Coniston	1	June 1	101
Callum	0	(July 10)	(55)
St. Charles	0	(Aug. 28)	(44)
Verner	0	(Sept. 14)	(32)
Burwash	0	(Sept. 23)	(49)
Hanmer	0	(May 24)	(92)
Rayside	1	Aug. 23	154
Morgan	0	(Oct. 12)	(44)
Lake Penage	0	(June 20)	(89)
TOTAL	9		

* Dates and intensity values in brackets indicate maximum seasonal fumigation intensities below 100 recorded at SO₂ monitoring stations.

Potentially Injurious Fumigations Recorded by Sudbury
Area SO₂ Monitors During the 1976 Growing Season

<u>Station</u>	<u>Number of</u> <u>P.I.F.</u>	<u>Date</u>	<u>Intensity</u>
Ash Street	0	(June 7) *	(75)
New Sudbury	4	June 5	124
	-	June 19	144
	-	June 20	101
	-	Oct. 3	126
Lockerby	1	May 12	131
Garson	0	(June 9)	(71)
Falconbridge Road	2	Aug. 20	162
	-	Oct. 25	121
Skead	7	May 5	221
	-	May 13	188
	-	June 13	107
	-	June 21	109
	-	Aug. 19	118
	-	Sept. 12	181
	-	Oct. 1	102
Chiniguchi Lake	0	(June 23)	(59)
Grassy Lake	0	(June 5)	(62)
Lake Temagami	0	(Aug. 16)	(27)
Coniston	1	Aug. 16	124
Callum	0	(May 26)	(82)
St. Charles	0	(May 14)	(62)
Verner	0	(Sept. 29)	(28)
Burwash	0	(Oct. 16)	(49)
Hanmer	2	May 28	104
	-	June 13	128
Rayside	0	(May 2)	(86)
Morgan	1	Sept. 21	111
Lake Penage	1	Sept. 17	104
<hr/>			
TOTAL	19		

* Dates and intensity values in brackets indicate maximum seasonal fumigation intensities below 100 recorded at SO₂ monitoring stations.

TABLE 6:

Potentially Injurious Fumigations Recorded by Sudbury
Area SO₂ Monitors During the 1977 Growing Season

<u>Station</u>	<u>Number of P.I.F.</u>	<u>Date</u>	<u>Intensity</u>
Ash Street	2	May 30	107
New Sudbury	3	June 11	218
	-	July 27	102
	-	Oct. 13	110
Lockerby	1	May 7	133
Falconbridge Road	2	June 10	122
	-	June 13	127
Skead	7	May 22	134
	-	July 12	160
	-	Aug. 21	144
	-	Aug. 28	232
	-	Oct. 24	111
	-	Oct. 25	232
	-	Oct. 27	127
Chiniguchi Lake	0	(May 31)*	(55)
Grassy Lake	0	(May 15)	(44)
Lake Temagami	0	(Aug. 4)	(21)
Coniston	0	(June 9)	(89)
Callum	0	(Sept. 18)	(74)
St. Charles	0	(Aug. 20)	(28)
Verner	0	(May 19)	(22)
Burwash	0	(Oct. 10)	(61)
Hanmer	3	May 4	110
	-	May 22	160
	-	Sept. 15	119
Rayside	0	(Sept. 2)	(93)
Morgan	1	Oct. 29	197
Lake Penage	0	(Sept. 30)	(78)
<hr/>			
TOTAL	19		

* Dates and intensity values in brackets indicate maximum seasonal fumigation intensities below 100 recorded at SO₂ monitoring stations.

Yearly Maximum Fumigation Intensities (P.I.F.) Recorded
at Sudbury Area SO₂ Monitors - 1970-1977

Max. Recorded At	Garson Skead	Garson Skead	Rayside Skead	Skead	Skead	Skead
	Rayside					

** The Garson monitor was moved to Falconbridge Road in June, 1976 therefore the value for only Falconbridge Road is used in 1976 summary.

TABLE 8

FREQUENCY OF POTENTIALLY INJURIOUS SO₂ FUMIGATIONS
IN THE SUDBURY AREA FROM 1967 TO 1977

	GARSON	SKEAD	KUKAGAMI	GRASSY LAKE	PENAGE	MORGAN	BURWASH	RAYSIDE	ST. CHARLES	CALLUM		ASH ST.	CONISTON	NEW SUDBURY	LOCKERBY	HANMER	CHINIGUCHI	TEMAGAMI	VERNER		NO. OF
YEAR											TOTAL									TOTAL	MONITORS
1967	19	24	4	0	3	5	0	10	0	8	73	-	-	-	-	-	-	-	-	73	10
1968	10	19	1	0	5	0	0	11	0	4	50	-	-	-	-	-	-	-	-	50	10
1969	8	19	1	0	0	0	1	4	1	0	34	-	-	-	-	-	-	-	-	34	10
1970	19	24	4	0	2	1	0	9	0	5	64	-	-	-	-	-	-	-	-	64	10
1971	18	24	5	0	3	1	1	8	0	1	61	27	-	-	-	-	-	-	-	88	11
1972	6	13	1	0	1	1	0	3	0	2	27	9	-	-	-	-	-	-	0	36	12
1973	2	3	0	0	0	0	0	2	0	0	7	1	-	-	-	0	-	-	0	8	13
1974	2	9	1	0	0	1	0	0	0	1	14	4	0	-	-	3	-	-	0	21	14
1975	3	3	-*	0	0	0	0	1	0	0	7	0	0	-	2	0	0	0	0	9	16
1976	2**	7	-	0	1	1	0	0	0	0	11	0	1	4	1	2	0	0	0	19	17
1977	2**	7	-	0	0	1	0	0	0	0	10	2	0	3	1	3	0	0	0	19	17
TOTAL	91	152	17	0	15	11	2	48	1	21	358	43	1	7	4	8	0	0	0	421	

** Garson Station relocated to Falconbridge Road in 1976 but reported together as Garson Station in this table.

* Station relocated to Chiniguchi in 1975

- Station nonexistant

Table 9:

CONCENTRATIONS OF SULPHUR (%) IN WHITE BIRCH
FOLIAGE SAMPLES COLLECTED IN THE SUDBURY AREA
1970 - 1976 **

Plot	Distance and Direction from Sudbury	Year					
		1970	1971	1972	1973	1975	1976
Blind River *	160 km W	.12	.14	.13	.14	.10	0.09
Mattawa *	176 km E	.17	.13	.16	.16	.09	0.11
Sudbury	0 km	.29	.35	.25	.18	.19	0.13
Milnet	37 km N	.25	.15	.25	.21	.14	0.11
Chiniguchi	57 km NNE	---	---	---	.21	.17	0.11
Garson	5 km NE	.41	.48	.30	.25	.30	0.26
Skead	26 km NE	.37	.36	.30	.32	.35	0.19
Kukagami L.	42 km NE	.27	.29	.21	.22	.21	0.16
Grassy L.	64 km NE	.18	.24	.16	.16	.13	0.13
Temagami	80 km NE	.22	.21	.19	.15	.16	0.13
Callum	29 km E	.24	.33	.20	.19	.13	0.12
Sturgeon Falls	77 km E	.17	.19	.18	.14	.13	0.09
St. Charles	48 km SE	.15	.20	.15	.12	.14	0.13
Burwash	27 km S	.26	.23	.26	.17	.16	0.14
Tilton L.	15 km SW	---	---	---	.17	.18	.14
Penage	37 km SW	.17	.21	.23	.18	.12	.13
Killarney	64 km SW	---	---	.18	.14	.16	.16
Nairn Centre	48 km WSW	.17	.18	.19	.15	.13	.12
Fairbanks L.	37 km W	---	---	---	.14	.10	.09
Rayside Twp.	16 km NW	.24	.22	.19	.24	.19	.13
Morgan Twp.	24 km NW	.17	.31	.22	.17	.12	.09

* Control Location

** Values reported are means of four monthly samples in 1970, three monthly samples in 1971 through 1974 and two monthly samples in triplicate in 1975 and 1976.

CONCENTRATIONS OF SULPHUR (%) IN TREMBLING ASPEN FOLIAGE
 SAMPLES COLLECTED IN THE SUDBURY AREA 1970 - 1974**

Plot	Distance and Direction From Sudbury	Year				
		1970	1971	1972	1973	1974
Blind River*	160 km W	.16	.22	.18	.20	.24
Mattawa*	176 km E	.19	.22	.19	.19	.21
Sudbury	0 km	.33	.42	.23	.21	.22
Milnet	37 km N	.26	.27	.24	.25	.24
Chiniguchi	57 km NNE	---	---	---	.26	.23
Garson	5 km NE	.44	.49	.30	.37	.28
Skead	26 km NE	.37	.50	.31	.39	.32
Kukagami L.	42 km NE	.40	.36	.33	.29	.20
Grassy L.	64 km NE	.22	.40	.24	.19	.25
Temagami	80 km NE	.33	.37	.31	.21	.22
Callum	29 km E	.27	.43	.29	.24	.25
Sturgeon Falls	77 km E	.18	.33	.23	.19	.22
St. Charles	48 km SE	.20	.29	.18	.17	.20
Burwash	27 km S	.32	.31	.31	.26	.25
Tilton L.	15 km SW	---	---	---	.29	.27
Penage	37 km SW	.23	.32	.34	.23	.27
Killarney	64 km SW	---	---	.25	.18	.26
Nairn Centre	48 km WSW	.21	.25	.23	.19	.24
Fairbanks L.	37 km W	---	---	---	.16	.22
Rayside Twp.	16 km NW	.27	.26	.24	.27	.19
Morgan Twp.	24 km NW	.20	.25	.26	.19	.22

* - Control location

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1971 through 1974.

Table 11:

CONCENTRATIONS OF SULPHUR (%) IN JACK PINE FOLIAGE
SAMPLES COLLECTED IN THE SUDBURY AREA, 1970 to 1974**

Plot	Distance and Direction From Sudbury	1 Year Old Foliage					Current Year				
		1970	1971	1972	1973	1974	1970	1971	1972	1973	1974
Blind River*	160 km W	.07	.08	.10	.08	.08	.10	.11	.11	.10	.07
Mattawa*	176 km E	.09	.10	.13	.09	.08	.12	.11	.12	.12	.09
Sudbury	0 km	.14	.21	.17	.13	.13	.14	.14	.15	.11	.08
Milnet	37 km N	.14	.14	.13	.13	.11	.14	.12	.14	.16	.11
Chiniguchi	57 km NNE	---	---	---	.11	.08	---	---	---	.17	.09
Garson	5 km NE	---	---	---	---	---	---	---	---	---	---
Skead	26 km NE	.26	.22	.21	.17	.15	.22	.23	.22	.19	.15
Kukagami L.	42 km NE	.18	.17	.14	.13	.13	.19	.18	.17	.13	.10
Grassy L.	64 km NE	.09	.13	.12	.09	.14	.11	.14	.15	.11	.09
Temagami	80 km NE	.10	.14	.15	.10	.09	.14	.17	.16	.10	.07
Callum	29 km E	.12	.15	.17	.10	.12	.16	.14	.14	.13	.11
Sturgeon Falls	77 km E	---	.14	.13	.09	.08	---	.13	.18	.10	.09
St. Charles	48 km SE	.12	.14	.17	.11	.10	.10	.13	.14	.13	.08
Burwash	27 km S	.16	.17	.21	.14	.11	.12	.14	.14	.12	.10
Tilton L.	15 km SW	---	---	---	---	---	---	---	---	---	---
Penage	37 km SW	---	---	---	---	---	---	---	---	---	---
Killarney	64 km SW	---	---	---	---	---	---	---	---	---	---
Nairn Centre	48 km WSW	.12	.14	.14	.11	.09	.12	.11	.13	.11	.09
Fairbanks L.	37 km W	---	---	---	.10	.08	---	---	---	.11	.09
Rayside Twp.	16 km NW	.12	.11	.14	.11	.10	.14	.14	.13	.12	.08
Morgan Twp.	24 km NW	.12	.15	.14	.10	.09	.15	.23	.14	.11	.10

* - Control Location

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1971 through 1974.

CONCENTRATIONS OF SULPHUR (%) IN BRACKEN FERN FOLIAGE

SAMPLES COLLECTED IN THE SUDBURY AREA 1970 - 1973**

Plot	Distance and Direction From Sudbury	Year			
		1970	1971	1972	1973
Blind River*	160 km W	.10	.13	.18	.19
Mattawa*	176 km E	.14	.14	.18	.15
Sudbury	0 km	.21	.22	.25	.20
Milnet	37 km N	.16	.18	.25	.23
Chiniguchi	57 km NNE	---	---	---	.17
Garson	5 km NE	.22	.31	.26	.19
Skead	26 km NE	.26	.28	.18	.18
Kukagami L.	42 km NE	.19	.30	.21	.18
Grassy L.	64 km NE	.14	.19	.18	.18
Temagami	80 km NE	.15	.16	.14	.17
Callum	29 km E	.18	.30	.21	.18
Sturgeon Falls	77 km E	.12	.19	.15	.13
St. Charles	48 km SE	.13	.14	.16	.14
Burwash	27 km S	.19	.28	.23	.19
Tilton L.	15 km SW	---	---	---	.14
Penage	37 km SW	.14	.16	.18	.20
Killarney	64 km SW	---	---	.18	.14
Nairn Centre	48 km WSW	.13	.19	.19	.21
Fairbanks L.	37 km W	---	---	---	.12
Rayside Twp.	16 km NW	.21	.21	.25	.13
Morgan Twp.	24 km NW	.20	.18	.18	.23

* - Control Location.

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1971 through 1973.

Table 13:

CONCENTRATIONS OF SULPHUR (%) IN GRASS FOLIAGE
SAMPLES COLLECTED IN THE SUDBURY AREA, 1970 - 1974**

Plot	Distance and Direction From Sudbury	Year				
		1970	1971	1972	1973	1974
Blind River*	160 km W	.14	.19	.18	.13	.21
Mattawa*	176 km E	.20	.15	.09	.18	.12
Sudbury	0 km	.22	.22	.19	.17	.28
Milnet	37 km N	.30	.28	.31	.25	.23
Chiniguchi	57 km NNE	---	---	---	.25	.14
Garson	5 km NE	.40	.28	.37	.16	.21
Skead	26 km NE	.41	.40	.30	.39	.36
Kukagami L.	42 km NE	.31	.31	.34	.19	.29
Grassy L.	64 km NE	.28	.34	.20	.16	.17
Temagami	80 km NE	.19	.18	.17	.15	.17
Callum	29 km E	.25	.25	.22	.22	.25
Sturgeon Falls	77 km E	.14	.31	.16	.16	.14
St. Charles	48 km SE	.22	.19	.21	.16	.21
Burwash	27 km S	.25	.24	.30	.17	.25
Tilton L.	15 km SW	---	---	---	.15	.26
Penage	37 km SW	.23	.21	.18	.25	.25
Killarney	64 km SW	---	---	.17	.18	.26
Nair Centre	48 km WSW	.19	.22	.19	.15	.17
Fairbanks L.	37 km W	---	---	---	.06	.19
Rayside Twp.	16 km NW	.27	.26	.23	.23	.16
Morgan Twp.	24 km NW	.29	.26	.24	.22	.14

* - Control Location

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1971 through 1974.

Table 14:

CONCENTRATIONS OF NICKEL ($\mu\text{g/g}$) IN WHITE BIRCH FOLIAGE
 SAMPLES COLLECTED IN THE SUDBURY AREA, 1970 - 1976**

Plot	Distance and Direction from Sudbury	YEAR					
		1970	1971	1972	1973	1975	1976
Blind River *	160 km W	3	8	7	4	7	5
Mattawa *	176 km E	3	5	5	4	7	9
Sudbury	0 km	58	81	82	77	112	93
Milnet	37 km N	42	16	25	19	16	23
Chiniguchi	57 km NNE	--	--	--	20	24	17
Garson	5 km NE	84	81	61	86	133	102
Skead	26 km NE	97	72	76	72	110	78
Kukagami L.	42 km NE	46	25	47	16	38	37
Grassy L.	64 km NE	13	11	16	11	24	16
Temagami	80 km NE	14	10	16	10	18	14
Callum	29 km E	44	45	44	47	58	33
Sturgeon Falls	77 km E	7	8	8	7	10	14
St. Charles	48 km SE	16	13	8	11	16	22
Burwash	27 km S	31	25	31	32	36	39
Tilton L.	15 km SW	--	--	--	58	59	78
Penage	37 km SW	13	10	19	16	22	28
Killarney	64 km SW	--	--	10	7	15	12
Nairn Centre	48 km WSW	8	13	12	8	10	10
Fairbanks L.	37 km W	--	--	--	15	18	16
Rayside Twp.	16 km NW	45	40	48	59	58	49
Morgan Twp.	24 km NW	18	23	19	13	19	11

* Control Location

** Values reported are means of four monthly samples in 1970, three monthly samples in 1971 through 1974, and two monthly samples in 1975 and 1976.

Table 15:

CONCENTRATIONS OF NICKEL ($\mu\text{g/g}$) IN TREMBLING ASPEN

FOLIAGE SAMPLES COLLECTED IN THE SUDBURY AREA, 1970 - 1974 **

Plot	Distance and Direction from Sudbury	Year				
		1970	1971	1972	1973	1974
Blind River *	160 km W	3	6	5	2	8
Mattawa *	176 km E	3	5	7	4	5
Sudbury	0 km	54	136	73	94	71
Milnet	37 km N	78	30	38	33	30
Chiniguchi	57 km NNE	--	--	--	42	31
Garson	5 km NE	99	59	82	128	91
Skead	26 km NE	83	76	57	68	40
Kukagami L.	42 km NE	45	58	53	53	54
Grassy L.	64 km NE	18	16	21	18	18
Temagami	80 km NE	15	13	18	14	10
Callum	29 km E	96	105	103	78	88
Sturgeon Falls	77 km E	9	9	7	9	11
St. Charles	48 km SE	12	17	16	21	15
Burwash	27 km S	36	62	55	36	48
Tilton L.	15 km SW	--	--	--	121	85
Penage	37 km SW	28	13	28	41	41
Killarney	64 km SW	--	--	9	7	18
Nairn Centre	48	15	17	15	15	20
Fairbanks L.	37 km W	--	--	--	41	42
Rayside Twp.	16 km NW	95	73	90	101	73
Morgan Twp.	28 km NW	28	31	38	31	25

* Control location

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1971 through 1974.

Table 10.

CONCENTRATIONS OF NICKEL ($\mu\text{g/g}$) IN JACK PINE
FOLIAGE SAMPLES COLLECTED IN THE SUDBURY AREA, 1970 - 1974**

Plot	Distance and Direction from Sudbury	1 Year Old Foliage					Current Year Foliage				
		1970	1971	1972	1973	1974	1970	1971	1972	1973	1974
Blind River *	160 km W	1	6	3	2	4	2	14	5	3	2
Mattawa *	176 km E	6	3	3	2	3	3	6	8	3	6
Sudbury	0 km	36	35	44	41	47	26	28	40	37	39
Milnet	37 km N	34	17	18	24	24	25	19	29	30	24
Chiniguchi	57 km NNE	--	--	--	9	16	--	--	--	18	20
Garson	5 km NE	--	--	--	--	--	--	--	--	--	--
Skead	26 km NE	55	44	48	55	44	60	45	54	37	33
Kukagami L.	42 km NE	35	17	37	27	49	39	23	50	25	38
Grassy L.	64 km NE	9	11	13	12	15	16	22	23	20	15
Temagami	80 km NE	10	8	13	13	10	18	13	21	20	6
Callum	29 km E	37	31	34	26	27	32	34	34	28	9
Sturgeon Falls	77 km E	--	12	8	8	8	--	10	10	9	5
St. Charles	48 km SE	5	10	11	9	11	9	12	19	28	9
Burwash	27 km S	17	18	20	16	22	22	17	29	28	18
Tilton L.	15 km SW	--	--	--	--	--	--	--	--	--	--
Penage	37 km SW	--	--	--	--	--	--	--	--	--	--
Killarney	64 km SW	--	--	--	--	--	--	--	--	--	--
Nairn Centre	48 km WSW	6	12	10	9	15	14	15	15	17	18
Fairbanks L.	37 km W	--	--	--	24	15	--	--	--	20	11
Rayside Twp.	16 km NW	38	29	28	32	29	40	30	41	37	20
Morgan Twp.	24 km NW	13	16	21	21	20	15	26	28	25	26

* Control Location

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1971 through 1974.

Table 17:

CONCENTRATIONS OF NICKEL ($\mu\text{g/g}$) IN BRACKEN FERN
FOLIAGE SAMPLES COLLECTED IN THE SUDBURY AREA, 1970-1973 **

Plot	Distance and Direction from Sudbury	Year			
		1970	1971	1972	1973
Blind River *	160 km W	1	6	6	5
Mattawa *	176 km E	2	4	4	2
Sudbury	0 km	66	30	74	52
Milnet	37 km N	20	10	18	19
Chiniguchi	57 km NNE	--	--	--	14
Garson	5 km NE	67	24	38	47
Skead	26 km NE	36	27	18	18
Kukagami L.	42 km NE	24	42	14	40
Grassy L.	64 km NE	3	6	7	7
Temagami	80 km NE	6	8	8	7
Callum	29 km E	42	18	35	27
Sturgeon Falls	77 km E	2	9	5	5
St. Charles	48 km SE	6	8	7	5
Burwash	27 km S	23	5	35	39
Tilton L.	15 km SW	--	--	--	38
Penage	37 km SW	9	5	7	5
Killarney	64 km SW	--	--	5	11
Nairn Centre	48 km WSW	9	10	9	9
Fairbanks L.	37 km W	--	--	--	5
Rayside Twp.	16 km NW	51	29	41	48
Morgan Twp.	24 km NW	7	6	10	12

* control location

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1971 through 1973.

Table 18:

CONCENTRATIONS OF NICKEL ($\mu\text{g/g}$) IN GRASS
FOLIAGE SAMPLES COLLECTED IN THE SUDBURY AREA, 1970-1974**

Plot	Distance and Direction from Sudbury	Year				
		1970	1971	1972	1973	1974
Blind River *	160 km W	2	2	5	3	5
Mattawa *	176 km E	3	8	4	3	3
Sudbury	0 km	24	34	51	26	47
Milnet	37 km N	37	3	10	16	22
Chiniguchi	57 km NNE	--	--	--	10	15
Garson	5 km NE	15	36	65	22	40
Skead	26 km NE	33	29	36	36	36
Kukagami L.	42 km NE	22	20	7	8	46
Grassy L.	64 km NE	6	7	8	7	9
Temagami	80 km NE	3	11	7	7	6
Callum	29 km E	30	29	49	22	32
Sturgeon Falls	77 km E	3	9	5	4	4
St. Charles	48 km SE	7	14	11	10	4
Burwash	27 km S	20	13	21	24	25
Tilton L.	15 km SW	--	--	--	24	52
Penage	37 km SW	7	15	15	9	7
Killarney	64 km SW	--	--	10	13	8
Nairn Centre	48 km WSW	5	10	9	6	10
Fairbanks L.	37 km W	--	--	--	7	10
Rayside Twp.	16 km NW	30	24	36	29	24
Morgan Twp.	24 km NW	19	5	30	8	9

* Control Location

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1971 through 1974.

Table 19:

CONCENTRATIONS OF COPPER ($\mu\text{g/g}$) IN WHITE BIRCH FOLIAGE SAMPLES
COLLECTED IN THE SUDBURY AREA
1970 - 1976 **

Plot	Distance and Direction from Sudbury	YEAR					
		1970	1971	1972	1973	1975	1976
Blind River*	160 km W	8	7	9	9	5	6
Mattawa*	176 km E	10	6	9	8	6	5
Sudbury	0 km	26	23	25	19	61	24
Milnet	37 km N	26	9	8	10	11	11
Chiniguchi	57 km NNE	--	--	--	6	14	8
Garson	5 km NE	61	48	24	26	52	22
Skead	26 km NE	59	25	14	29	58	22
Kukagami L.	42 km NE	39	14	10	12	17	9
Grassy L.	64 km NE	11	10	13	10	11	11
Temagami	80 km NE	20	11	13	11	10	8
Callum	29 km E	23	14	9	11	14	8
Sturgeon Falls	77 km E	12	8	9	9	9	6
St. Charles	48 km SE	16	8	7	9	12	8
Burwash	27 km S	23	12	12	11	13	11
Tilton L.	15 km SW	--	--	--	15	29	24
Penage	37 km SW	22	9	13	7	11	11
Killarney	64 km SW	--	--	9	8	9	13
Nairn Centre	48 km WSW	10	11	13	10	7	8
Fairbanks L.	37 km W	--	--	--	7	7	9
Rayside Twp.	16 km NW	24	21	13	14	25	17
Morgan Twp.	24 km NW	19	16	13	8	12	8

* Control Location

** Values reported are means of four monthly samples in 1970, three monthly samples in 1971 through 1974 and two monthly samples in triplicate in 1975 and 1976.

Table 20:

CONCENTRATIONS OF COPPER ($\mu\text{g/g}$) in TREMBLING ASPEN
FOLIAGE SAMPLES COLLECTED IN THE SUDBURY AREA
1970 - 1974 **

Plot	Distance and Direction from Sudbury	YEAR				
		1970	1971	1972	1973	1974
Blind River*	160 km W	6	10	13	10	10
Mattawa*	176 km E	11	8	10	9	6
Sudbury	0 km	17	14	9	8	12
Milnet	37 km N	23	9	9	8	5
Chiniguchi	57 km NNE	--	--	--	6	5
Garson	5 km NE	27	29	14	14	24
Skead	25 km NE	38	15	15	15	24
Kukagami L.	42 km NE	22	12	14	14	14
Grassy L.	64 km NE	10	10	10	10	5
Temagami	80 km NE	21	11	14	13	7
Callum	29 km E	14	12	9	10	18
Sturgeon Falls	77 km E	10	11	10	11	7
St. Charles	48 km SE	15	9	8	9	12
Burwash	27 km S	21	11	12	8	4
Tilton L.	15 km SW	--	--	--	10	4
Penage	37 km SW	19	10	15	9	8
Killarney	64 km SW	--	--	9	9	5
Nairn Centre	48 km WSW	11	11	14	10	5
Fairbanks L.	37 km W	--	--	--	8	4
Rayside Twp.	16 km NW	28	10	11	10	13
Morgan Twp.	24 km NW	17	9	14	9	12

* Control location

** values reported are means of four monthly samples in 1970 and three monthly samples in 1971 through 1974.

Table 21:

CONCENTRATIONS OF COPPER ($\mu\text{g/g}$) IN JACK PINE FOLIAGE
 SAMPLES COLLECTED IN THE SUDBURY AREA, 1970 - 1974**

Plot	Distance and Direction From Sudbury	1 Year Old Foliage					Current Year Foliage				
		1970	1971	1972	1973	1974	1970	1971	1972	1973	1974
Blind River*	160 km W	2	5	3	3	3	2	5	6	4	7
Mattawa*	176 km E	6	4	5	2	6	5	5	7	4	ND
Sudbury	0 km	21	13	35	12	28	9	9	21	8	12
Milnet	37 km N	34	11	9	5	7	19	6	7	4	2
Chiniguchi	57 km NNE	--	--	--	4	4	--	--	--	3	3
Garson	5 km NE	--	--	--	--	--	--	--	--	--	--
Skead	26 km NE	55	26	25	29	33	29	18	12	19	23
Kukagami L.	42 km NE	35	8	14	11	29	15	8	9	8	20
Grassy L.	64 km NE	9	6	6	7	2	6	7	12	7	ND
Temagami	80 km NE	10	4	6	5	3	12	5	9	5	ND
Callum	29 km E	15	10	11	8	17	9	8	7	6	10
Sturgeon Falls	77 km E	--	7	8	5	5	--	7	5	5	7
St. Charles	48 km SE	6	7	8	5	6	5	7	8	6	10
Burwash	27 km S	11	7	10	5	4	6	6	10	5	1
Tilton L.	15 km SW	--	--	--	--	--	--	--	--	--	--
Penage	37 km SW	--	--	--	--	--	--	--	--	--	--
Killarney	64 km SW	--	--	--	--	--	--	--	--	--	--
Nairn Centre	48 km WSW	10	6	5	5	5	3	6	8	4	ND
Fairbanks L.	37 km W	--	--	--	6	2	--	--	--	4	ND
Rayside Twp.	16 km NW	38	10	10	8	14	13	6	6	7	9
Morgan Twp.	24 km NW	17	9	7	4	9	8	4	7	4	ND

* - Control Location.

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1971 through 1974.

CONCENTRATIONS OF COPPER ($\mu\text{g/g}$) IN BRACKEN FERN FOLIAGE
 SAMPLES COLLECTED IN THE SUDBURY AREA
 1970 - 1973**

Plot	Distance and Direction from Sudbury	YEAR			
		1970	1971	1972	1973
Blind River*	160 km W	3	6	10	3
Mattawa*	176 km E	9	6	8	6
Sudbury	0 km	21	20	20	15
Milnet	37 km N	13	7	16	8
Chiniguchi	57 km NNE	--	--	--	7
Garson	5 km NE	24	20	25	23
Skead	26 km NE	17	14	9	10
Kukagami L.	42 km NE	10	10	9	7
Grassy L.	64 km NE	6	9	9	11
Temagami	80 km NE	13	9	8	10
Callum	29 km E	20	9	8	10
Sturgeon Falls	77 km E	4	8	5	7
St. Charles	48 km SE	8	8	16	7
Burwash	27 km S	20	8	16	10
Tilton L.	15 km SW	--	--	--	15
Penage	37 km SW	9	6	14	5
Killarney	64 km SW	--	--	8	7
Nairn Centre	48 km WSW	2	7	12	9
Fairbanks L.	37 km W	--	--	--	5
Rayside Twp.	16 km NW	16	11	11	12
Morgan Twp.	24 km NW	8	7	9	10

* Control location

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1971 through 1973.

Table 23:

CONCENTRATIONS OF COPPER ($\mu\text{g/g}$) IN GRASS FOLIAGE SAMPLES
COLLECTED IN THE SUDBURY AREA
1970 - 1974**

Plot	Distance and Direction from Sudbury	YEAR				
		1970	1971	1972	1973	1974
Blind River*	160 km W	9	5	8	5	6
Mattawa*	176 km E	9	5	2	3	4
Sudbury	0 km	18	7	17	7	18
Milnet	37 km N	15	10	18	6	7
Chiniguchi	57 km NNE	--	--	--	5	3
Garson	5 km NE	35	12	58	11	22
Skead	26 km NE	36	12	19	10	39
Kukagami L.	42 km NE	18	11	15	7	12
Grassy L.	64 km NE	12	12	6	6	3
Temagami	80 km NE	12	7	4	5	5
Callum	29 km E	16	8	9	6	14
Sturgeon Falls	77 km E	11	9	5	7	5
St. Charles	48 km SE	10	5	5	4	8
Burwash	27 km S	17	8	3	5	6
Tilton L.	15 km SW	--	--	--	7	7
Penage	37 km SW	19	8	12	6	6
Killarney	64 km SW	--	--	8	10	5
Nairn Centre	48 km WSW	8	8	5	7	5
Fairbanks L.	37 km W	--	--	--	3	2
Rayside Twp.	16 km NW	14	7	20	6	16
Morgan Twp.	24 km NW	13	9	17	7	7

* Control location

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1971 through 1974.

Table 24:

CONCENTRATIONS OF IRON ($\mu\text{g/g}$) IN WHITE BIRCH FOLIAGE
 SAMPLES COLLECTED IN THE SUDBURY AREA
 1970 - 1976**

Plot	Distance and Direction from Sudbury	YEAR					
		1970	1971	1972	1973	1975	1976
Blind River*	160 km W	54	97	79	81	163	170
Mattawa*	176 km E	54	74	51	101	76	110
Sudbury	0 km	162	311	163	152	435	169
Milnet	37 km N	141	147	157	196	264	133
Chiniguchi	57 km NNE	--	--	--	94	188	61
Garson	5 km NE	235	360	136	183	340	188
Skead	26 km NE	423	342	229	170	466	210
Kukagami L.	42 km NE	321	133	79	108	152	123
Grassy L.	64 km NE	103	95	85	88	150	196
Temagami	80 km NE	137	345	150	171	1073	474
Callum	29 km E	125	187	139	137	323	160
Sturgeon Falls	77 km E	44	122	121	106	382	68
St. Charles	48 km SE	110	176	109	99	337	214
Burwash	27 km S	186	156	125	171	446	156
Tilton L.	15 km SW	--	--	--	161	363	292
Penage	37 km SW	74	71	93	81	476	242
Killarney	64 km SW	--	--	75	90	98	200
Nairn Centre	48 km WSW	75	92	85	92	93	83
Fairbanks L.	37 km W	--	--	--	67	97	50
Rayside Twp.	16 km NW	130	447	152	173	406	198
Morgan Twp.	24 km NW	140	267	215	151	571	144

* Control location

** Values reported are means of four monthly samples in 1970, three monthly samples in 1971 through 1974 and two monthly samples in triplicate in 1975 and 1976.

CONCENTRATIONS OF IRON ($\mu\text{g/g}$) IN TREMBLING ASPEN
FOLIAGE SAMPLES COLLECTED IN THE SUDBURY AREA
1970 - 1974**

Plot	Distance and Direction from Sudbury	YEAR				
		1970	1971	1972	1973	1974
Blind River*	160 km W	45	62	49	45	70
Mattawa*	176 km E	62	81	53	64	65
Sudbury	0 km	125	362	69	76	71
Milnet	37 km N	159	94	99	107	124
Chiniguchi	57 km NNE	--	--	--	85	68
Garson	5 km NE	144	317	69	75	86
Skead	26 km NE	437	242	283	137	113
Kukagami L.	42 km NE	184	173	183	163	250
Grassy L.	64 km NE	69	101	45	67	76
Temagami	80 km NE	159	317	150	152	85
Callum	29 km E	98	150	71	168	99
Sturgeon Falls	77 km E	45	130	88	108	67
St. Charles	48 km SE	124	175	92	77	62
Burwash	27 km S	173	178	180	117	148
Tilton L.	15 km SW	--	--	--	99	46
Penage	37 km SW	74	98	63	88	137
Killarney	64 km SW	--	--	51	71	122
Nairn Centre	48 km WSW	81	102	67	85	92
Fairbanks L.	37 km W	--	--	--	53	52
Rayside Twp.	16 km NW	167	286	176	191	72
Morgan Twp.	24 km NW	188	132	105	212	120

* Control location

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1971 through 1974.

Table 26:

CONCENTRATIONS OF IRON ($\mu\text{g/g}$) IN JACK PINE FOLIAGE

SAMPLES COLLECTED IN THE SUDBURY AREA, 1970 - 1974**

Plot	Distance and Direction From Sudbury	1 Year Old Foliage					Current Year Foliage				
		1970	1971	1972	1973	1974	1970	1971	1972	1973	1974
Blind River*	160 km W	35	43	56	54	77	24	47	32	34	30
Mattawa*	176 km E	62	84	87	88	89	36	54	43	58	50
Sudbury	0 km	191	305	254	180	181	47	111	62	58	44
Milnet	37 km N	105	150	124	129	150	82	76	52	60	139
Chiniguchi	57 km NNE	---	---	---	70	112	---	---	---	50	50
Garson	5 km NE	---	---	---	---	---	---	---	---	---	---
Skead	26 km NE	503	784	419	211	125	306	403	99	102	70
Kukagami L.	42 km NE	239	197	219	160	180	118	91	69	71	95
Grassy L.	64 km NE	93	91	110	91	65	60	60	49	43	31
Temagami	80 km NE	132	183	181	149	205	97	115	71	72	94
Callum	29 km E	125	162	100	139	102	52	75	44	53	90
Sturgeon Falls	77 km E	---	119	119	96	152	---	90	41	49	22
St. Charles	48 km SE	99	259	165	112	122	64	173	58	53	128
Burwash	27 km S	118	169	167	121	122	70	128	72	70	51
Tilton L.	15 km SW	---	---	---	---	---	---	---	---	---	---
Penage	37 km SW	---	---	---	---	---	---	---	---	---	---
Killarney	64 km SW	---	---	---	---	---	---	---	---	---	---
Nairn Centre	48 km WSW	69	112	98	106	117	40	61	46	49	56
Fairbanks L.	37 km W	---	---	---	72	78	---	---	---	34	44
Rayside Twp.	16 km NW	141	206	174	210	103	113	351	82	74	34
Morgan Twp.	24 km NW	119	262	152	133	116	91	180	77	84	90

* - Control Location.

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1971 through 1974.

CONCENTRATIONS OF IRON ($\mu\text{g/g}$) IN BRACKEN FERN FOLIAGE
 SAMPLES COLLECTED IN THE SUDBURY AREA
 1970 - 1973**

Plot	Distance and Direction from Sudbury	YEAR			
		1970	1971	1972	1973
Blind River*	160 km W	61	83	80	65
Mattawa*	176 km E	77	91	73	98
Sudbury	0 km	115	181	96	79
Milnet	37 km N	112	116	95	97
Chiniguchi	57 km NNE	--	--	--	75
Garson	5 km NE	160	212	105	92
Skead	26 km NE	211	200	75	118
Kukagami L.	42 km NE	108	144	69	63
Grassy L.	64 km NE	99	168	78	64
Temagami	80 km NE	162	267	112	149
Callum	29 km E	182	116	81	111
Sturgeon Falls	77 km E	65	141	104	92
St. Charles	48 km SE	152	123	80	65
Burwash	27 km S	164	124	96	130
Tilton L.	15 km SW	--	--	--	99
Penage	37 km SW	106	128	97	65
Killarney	64 km SW	--	--	70	85
Nairn Centre	48 km WSW	102	91	60	87
Fairbanks L.	37 km W	--	--	--	52
Rayside Twp.	16 km NW	136	169	88	94
Morgan Twp.	24 km NW	103	128	77	118

* Control location

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1971 through 1973.

CONCENTRATIONS OF IRON ($\mu\text{g/g}$) IN GRASS FOLIAGE SAMPLES
COLLECTED IN THE SUDBURY AREA
1970 - 1974**

Plot	Distance and Direction from Sudbury	YEAR				
		1970	1971	1972	1973	1974
Blind River*	160 km W	40	70	79	80	48
Mattawa*	176 km E	100	122	158	82	127
Sudbury	0 km	121	291	69	67	126
Milnet	37 km N	98	98	151	287	140
Chiniguchi	57 km NNE	--	--	--	121	57
Garson	5 km NE	122	267	262	122	112
Skead	26 km NE	234	281	241	126	85
Kukagami L.	42 km NE	112	237	87	114	183
Grassy L.	64 km NE	73	95	155	107	65
Temagami	80 km NE	148	453	163	193	106
Callum	29 km E	110	134	119	183	132
Sturgeon Falls	77 km E	82	268	63	98	59
St. Charles	48 km SE	97	141	119	84	86
Burwash	27 km S	108	376	70	106	263
Tilton L.	15 km SW	--	--	--	118	41
Penage	37 km SW	79	85	147	54	63
Killarney	64 km SW	--	--	62	133	122
Nairn Centre	48 km WSW	59	96	46	93	146
Fairbanks L.	37 km W	--	--	--	31	87
Rayside Twp.	16 km NW	139	278	240	88	137
Morgan Twp.	24 km NW	115	346	174	214	148

* Control location

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1971 through 1974.

Table 29:

CONCENTRATIONS OF ARSENIC ($\mu\text{g/g}$) IN WHITE BIRCH
FOLIAGE SAMPLES COLLECTED IN THE SUDBURY AREA
1970 - 1976 **

Plot	Distance and Direction from Sudbury	Year					
		1970	1971	1972	1973	1975	1976
Blind River *	160 km W	< .5	.6	.8	< .4	< .3	0.3
Mattawa *	176 km E	.6	1.1	.4	< .4	< .3	0.3
Sudbury	0 km	.5	2.8	1.2	1.8	2.0	.9
Milnet	37 km N	1.4	1.7	1.6	1.6	.7	.3
Chiniguchi	57 km NNE	---	---	---	.6	1.1	.5
Garson	5 km NE	2.0	5.4	1.8	1.7	2.7	1.7
Skead	26 km NE	4.4	3.6	2.4	2.4	8.5	1.9
Kukagami L.	42 km NE	2.2	1.9	1.6	.8	1.5	1.1
Grassy L.	64 km NE	.7	1.5	.7	< .4	.8	.5
Temagami	80 km NE	.6	1.3	.7	< .4	.6	.4
Callum	29 km E	1.1	1.4	1.0	.6	1.1	.7
Sturgeon Falls	77 km E	.7	1.4	.6	< .4	.4	.3
St. Charles	48 km SE	.7	1.0	.5	< .4	.9	.4
Burwash	27 km S	.7	1.4	.6	.4	1.0	.6
Tilton L.	15 km SW	---	---	---	1.6	1.7	1.1
Penage	37 km SW	< .5	1.2	.4	< .4	.8	.4
Killarney	64 km SW	---	---	---	< .4	.3	.4
Hairn Centre	48 km WSW	.6	1.7	1.0	.4	< .3	.5
Fairbanks L.	37 km W	---	---	---	.4	.3	.4
Rayside Twp.	16 km NW	.7	1.6	.6	1.6	1.4	.8
Morgan Twp.	24 km NW	< .5	1.4	.7	.6	.5	.3

* Control Location

** Values reported are means of four monthly samples in 1970, three monthly samples in 1971 through 1974 and two monthly samples in triplicate in 1975 and 1976.

CONCENTRATIONS OF ARSENIC ($\mu\text{g/g}$) IN TREMBLING ASPEN
FOLIAGE SAMPLES COLLECTED IN THE SUDBURY AREA
1970 - 1974**

Plot	Distance and Direction from Sudbury	YEAR				
		1970	1971	1972	1973	1974
Blind River*	160 km W	< .5	1.0	.8	.4	< .3
Mattawa*	176 km E	.6	.8	.6	.4	< .3
Sudbury	0 km	< .5	2.5	3.8	2.0	.7
Milnet	37 km N	.9	.9	.8	--	.4
Chiniguchi	57 km NNE	--	--	--	.7	.3
Garson	5 km NE	.6	4.9	.9	2.3	1.1
Skead	26 km NE	3.8	3.4	1.8	1.7	3.4
Kukagami L.	42 km NE	.6	1.5	1.1	1.0	1.1
Grassy L.	64 km NE	< .5	2.1	.8	.5	.3
Temagami	80 km NE	< .5	1.5	.5	.4	.3
Callum	29 km E	1.0	2.0	1.0	1.0	.9
Sturgeon Falls	77 km E	.5	1.1	.6	< .4	< .3
St. Charles	48 km SE	.8	2.5	.6	.6	.4
Burwash	27 km S	.7	1.4	1.1	.4	.4
Tilton L.	15 km SW	--	--	--	.7	.6
Penage	37 km SW	.5	1.4	.4	.6	.3
Killarney	64 km SW	--	--	.9	.4	< .3
Nairn Centre	38 km WSW	.6	.6	.8	.7	< .3
Fairbanks L.	37 km W	--	--	--	.4	< .3
Rayside Twp.	16 km NW	.9	1.2	.3	1.6	.3
Morgan Twp.	24 km NW	.5	1.0	1.1	.6	.3

* Control location

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1971 through 1974.

CONCENTRATIONS OF ARSENIC ($\mu\text{g/g}$) IN JACK PINE

FOLIAGE SAMPLES COLLECTED IN THE SUDBURY AREA 1970-1974**

Plot	Distance and Direction from Sudbury	1 Year Old Foliage					Current Year Foliage				
		1970	1971	1972	1973	1974	1970	1971	1972	1973	1974
Blind River *	160 km W	< .5	1.2	.8	< .4	< .3	< .5	.8	.5	< .4	< .3
Mattawa *	176 km E	< .5	1.3	.5	< .4	< .3	.5	.9	.6	< .5	< .3
Sudbury	0 km	.5	3.7	3.2	2.3	1.6	< .5	2.0	1.7	1.5	.5
Milnet	37 km N	.9	1.6	.7	1.5	.5	< .5	1.4	.7	1.5	< .3
Chiniguchi	57 km NNE	---	---	---	.6	.3	---	---	---	< .5	< .3
Garson	5 km NE	---	---	---	---	---	---	---	---	---	---
Skead	26 km NE	5.8	11.0	4.0	5.9	3.7	1.7	6.4	.8	1.7	.9
Kukagami L.	42 km NE	2.0	1.6	5.3	2.3	3.8	.6	1.2	2.3	1.0	1.2
Grassy L.	64 km NE	.5	1.8	.9	< .5	< .3	< .5	.8	1.0	< .4	< .3
Temagami	80 km NE	< .5	1.4	.9	< .4	.4	< .5	1.2	.4	< .4	< .3
Callum	29 km E	.8	1.8	1.0	.7	.9	.8	1.5	.6	< .5	1.4
Sturgeon Falls	77 km E	---	2.0	1.0	< .4	< .3	---	.8	.4	< .4	< .3
St. Charles	48 km SE	.5	1.5	1.0	< .5	.3	< .5	.7	.6	< .5	< .3
Burwash	27 km S	.8	2.0	1.0	.7	.3	< .5	.9	.6	< .4	.3
Tilton L.	15 km SW	---	---	---	---	---	---	---	---	---	---
Penage	37 km SW	.6	2.0	.3	---	---	< .5	1.0	.4	---	---
Killarney	64 km SW	---	---	---	.9	---	---	---	---	< .4	---
Nairn Centre	48 km WSW	< .5	1.1	.5	< .4	< .3	< .5	.7	.5	< .4	.5
Fairbanks L.	37 km W	---	---	---	< .5	< .3	---	---	---	< .5	< .3
Rayside Twp.	16 km NW	.8	2.5	.8	1.9	.6	< .5	1.9	.8	2.4	< .3
Morgan Twp.	24 km NW	.5	1.5	1.0	.6	.3	< .5	1.9	.8	< .5	< .3

* Control locations

** values reported are means of four monthly samples in 1970 and three monthly samples in 1971 through 1974.

Table 32:

CONCENTRATIONS OF ARSENIC ($\mu\text{g/g}$) IN BRACKEN FERN FOLIAGE SAMPLES
COLLECTED IN THE SUDBURY AREA
1970 - 1974**

Plot	Distance and Direction from Sudbury	YEAR				
		1970	1971	1972	1973	1974
Blind River*	160 km W	< .5	1.5	.4	< .5	
Mattawa*	176 km E	< .5	.9	1.0	< .5	
Sudbury	0 km	< .5	2.7	.7	.9	
Milnet	37 km N	.6	1.3	1.4	2.5	
Chiniguchi	57 km NNE	--	--	--	< .5	
Garson	5 km NE	1.2	3.3	.9	1.6	
Skead	26 km NE	2.3	3.4	.3	1.4	
Kukagami L.	42 km NE	.7	1.4	1.4	.6	
Grassy L.	64 km NE	.8	1.9	.5	< .5	
Temagami	80 km NE	< .5	1.2	.8	< .5	
Callum	29 km E	1.0	2.6	.9	.5	
Sturgeon Falls	77 km E	.6	1.8	.8	< .5	
St. Charles	48 km SE	.5	1.5	< .3	.6	
Burwash	27 km S	.8	1.3	.5	< .5	
Tilton L.	15 km SW	--	--	--	< .5	
Penage	37 km SW	1.3	2.6	.9	.5	
Killarney	64 km SW	--	--	.8	.4	
Nairn Centre	48 km WSW	.6	.7	.4	< .5	
Fairbanks	37 km W	--	--	--	< .5	
Rayside Twp.	16 km NW	< .5	1.4	.5	.6	
Morgan Twp.	24 km NW	< .5	.7	.4	.6	

* Control location

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1971 through 1974.

Table 33:

CONCENTRATIONS OF ARSENIC ($\mu\text{g/g}$) IN FORAGE
FOLIAGE SAMPLES COLLECTED IN THE SUDBURY AREA 1970-1974**

Plot	Distance and Direction from Sudbury	Year				
		1970	1971	1972	1973	1974
Blind River *	160 km W	< .5	.9	.8	< .4	< .3
Mattawa *	176 km E	.5	1.1	.9	.4	< .3
Sudbury	0 km	< .5	2.0	2.3	2.2	.7
Milnet	37 km N	.5	1.3	.6	.3	.3
Chiniguchi	56 km NNE	---	---	---	.7	.3
Garson	5 km NE	2.1	3.5	2.0	1.6	1.0
Skead	26 km NE	1.2	3.7	1.1	1.6	2.2
Kukagami L.	42 km NE	.9	.8	.6	< .5	.8
Grassy L.	64 km NE	.6	1.1	.7	.5	< .3
Temagami	80 km NE	< .5	1.5	.9	< .5	< .3
Callum	29 km E	.7	1.6	.8	.5	.9
Sturgeon Falls	77 km E	< .5	1.4	.7	< .5	< .3
St. Charles	48 km SE	< .5	1.4	.4	.5	< .3
Burwash	27 km S	1.2	1.4	.7	1.1	.4
Tilton L.	15 km SW	---	---	---	.8	.3
Penage	37 km SW	< .5	1.4	.5	.6	< .3
Killarney	64 km SW	---	---	.7	< .4	< .3
Nairn Centre	48 km WSW	< .5	1.0	.6	< .4	< .3
Fairbanks L.	37 km W	---	---	---	< .4	< .3
Rayside Twp.	16 km NW	< .5	1.9	1.2	.6	1.0
Morgan Twp.	24 km NW	< .5	1.1	.4	.6	.3

* Control location

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1971 through 1974.

- Table 34:

CONCENTRATIONS OF SELENIUM ($\mu\text{g/g}$) IN WHITE BIRCH FOLIAGE
SAMPLES COLLECTED IN THE SUDBURY AREA
1970 - 1973**

Plot	Distance and Direction from Sudbury	YEAR		
		1970	1972	1973
Blind River *	160 km W	--	--	.20
Mattawa*	176 km E	.70	--	.17
Sudbury	0 km	--	--	.46
Milnet	37 km N	--	--	.30
Chiniguchi	57 km NNE	--	--	.18
Garson	5 km NE	1.06	.25	.30
Skead	26 km NE	.79	.26	.40
Kukagami L.	42 km NE	.93	--	.26
Grassy L.	64 km NE	.79	--	.30
Temagami	80 km NE	.74	--	.18
Callum	29 km E	--	.27	.33
Sturgeon Falls	77 km E	--	--	.14
St. Charles	48 km SE	--	.22	.18
Burwash	27 km S	--	.15	.15
Tilton L.	15 km SW	--	--	.42
Penage	37 km SW	.77	--	.33
Killarney	64 km SW	--	--	.15
Nairn Centre	48 km WSW	--	--	.19
Fairbanks L.	37 km N	--	--	.27
Rayside Twp.	16 km NW	--	--	.38
Morgan Twp.	24 km NW	--	--	.30

* Control location

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1972 and 1973.

CONCENTRATIONS OF SELENIUM ($\mu\text{g/g}$) IN TREMBLING ASPEN FOLIAGE

SAMPLES COLLECTED IN THE SUDBURY AREA

1970 - 1973**

Plot	Distance and Direction from Sudbury	YEAR		
		1970	1972	1973
Blind River*	160 km W	--	--	.24
Mattawa*	176 km E	.78	--	.18
Sudbury	0 km	--	.45	.61
Milnet	37 km N	--	--	.43
Chiniguchi	57 km NNE	--	--	.21
Garson	5 km NE	1.12	.28	.20
Skead	26 km NE	1.14	.41	.64
Kukagami L.	42 km NE	.84	.24	.28
Grassy L.	64 km NE	.70	--	.32
Temagami	80 km NE	.62	--	.29
Callum	29 km E	.87	.32	.34
Sturgeon Falls	77 km E	--	--	.18
St. Charles	48 km SE	--	.33	.25
Burwash	27 km S	--	.24	.17
Tilton L.	15 km SW	--	--	.42
Penage	37 km SW	.94	.20	.42
Killarney	64 km SW	--	--	.04
Nairn Centre	48 km WSW	--	--	.35
Fairbanks L.	37 km N	--	--	.24
Rayside Twp.	16 km NW	--	--	.40
Morgan Twp.	24 km NW	--	--	.31

* Control location

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1972 and 1973.

CONCENTRATIONS OF SELENIUM ($\mu\text{g/g}$) IN JACK PINE
FOLIAGE SAMPLES COLLECTED IN THE SUDBURY AREA, 1970 - 1973**

Plot	Distance and Direction from Sudbury	1 Year Old Foliage			Current Year Foliage		
		1970	1972	1973	1970	1972	1973
Blind River *	160 km W	---	---	.24	---	---	.20
Mattawa *	176 km F	.54	---	.17	.43	---	.10
Sudbury		---	---	.31	---	.06	.14
Milnet	37 km N	---	---	.30	---	---	.24
Chiniguchi	57 km NNE	---	---	.32	---	---	.12
Garson	5 km NE	---	---	---	---	---	---
Skead	26 km NE	.68	.51	.45	.46	.12	.23
Kukagami L.	42 km NE	.53	---	.31	.45	---	.12
Grassy L.	64 km NE	.65	---	.23	.57	---	.19
Temagami	80 km NE	.39	---	.24	.49	---	.16
Callum	29 km E	---	.16	.31	---	.12	.05
Sturgeon Falls	77 km E	---	---	.13	---	---	.15
St. Charles	48 km SE	---	.32	.22	---	.25	.20
Burwash	27 km S	---	.22	.28	---	.15	.10
Tilton L.	15 km SW	---	---	---	---	---	---
Penage	37 km SW	.61	---	---	.35	---	---
Killarney	64 km SW	---	---	---	---	---	---
Nairn Centre	48 km WSW	---	---	.27	---	---	.18
Fairbanks L.	37 km W	---	---	.15	---	---	.13
Rayside Twp.	16 km NW	---	---	.37	---	---	.23
Morgan Twp.	24 km NW	---	---	.38	---	---	---

*Control location

**Values reported are means of four monthly samples in 1970 and three monthly samples in 1972 and 1973

CONCENTRATIONS OF SELENIUM ($\mu\text{g/g}$) IN BRACKEN FERN FOLIAGE
 SAMPLES COLLECTED IN THE SUDBURY AREA, 1970 - 1973**

Plot	Distance and Direction From Sudbury	YEAR		
		1970	1972	1973
Blind River*	160 km W	---	---	.08
Mattawa*	176 km E	.33	---	.20
Sudbury	0 km	---	---	.43
Milnet	37 km N	---	---	.14
Chiniguchi	57 km NNE	---	---	.20
Garson	5 km NE	.73	.25	.41
Skead	26 km NE	.48	---	---
Kukagami L.	42 km NE	.46	---	.20
Grassy L.	64 km NE	.37	.10	.11
Temagami	80 km NE	.50	---	.11
Callum	29 km E	---	.14	.26
Sturgeon Falls	77 km E	---	---	.16
St. Charles	48 km SE	---	.08	.17
Burwash	27 km S	---	.15	.11
Tilton L.	15 km SW	---	---	.19
Penage	37 km SW	.46	---	.23
Killarney	64 km SW	---	---	.05
Nairn Centre	48 km WSW	---	---	.17
Fairbanks L.	37 km N	---	---	.09
Rayside Twp	16 km NW	---	---	.30
Morgan Twp.	24 km NW	---	---	.27

* Control location

** Values reported are means of four monthly samples in 1970 and three monthly values in 1972 and 1973.

Table 38:

CONCENTRATIONS OF SELENIUM ($\mu\text{g/g}$) IN FORAGE

FOLIAGE SAMPLES COLLECTED IN THE SUDBURY AREA, 1970-1973**

Plot	Distance and Direction from Sudbury	Year		
		1970	1972	1973
Blind River *	160 km W	---	.16	.14
Mattawa *	176 km E	.52	.15	.13
Sudbury	0 km	---	.22	.36
Milnet	37 km N	---	.19	.35
Chiniguchi	57 km NNE	---	---	.27
Garson	5 km NE	.81	.33	.46
Skead	26 km NE	.67	.20	.51
Kukagami L.	42 km NE	.58	.15	.25
Grassy L.	64 km NE	.48	.14	.20
Temagami	80 km NE	.45	.17	.24
Callum	29 km E	---	.18	.23
Sturgeon Falls	77 km E	---	.08	.12
St. Charles	48 km SE	---	.08	.11
Burwash	27 km S	---	.16	.18
Tilton L.	15 km SW	---	---	.12
Penage	37 km SW	.57	.20	.22
Killarney	64 km SW	---	.12	.11
Nairn Centre	48 km WSW	---	.14	.14
Fairbanks L.	37 km W	---	---	.12
Rayside Twp.	16 km NW	---	.29	.33
Morgan Twp.	24 km NW	---	.14	.13

* Control location

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1971 and 1973.

Table 39:

CONCENTRATIONS OF ZINC ($\mu\text{g/g}$) IN WHITE BIRCH
FOLIAGE SAMPLES COLLECTED IN THE SUDBURY AREA, 1970 - 1973**

Plot	Distance and Direction from Sudbury	Year			
		1970	1971	1972	1973
Blind River *	160 km W	296	607	337	279
Mattawa *	176 km E	270	157	298	356
Sudbury	0 km	90	84	61	108
Milnet	37 km N	158	150	172	251
Chiniguchi	57 km NNE	---	---	---	169
Garson	5 km NE	114	66	80	87
Skead	26 km NE	188	129	100	147
Kukagami L.	42 km NE	213	160	116	175
Grassy L.	64 km NE	237	143	208	169
Temagami	80 km NE	151	250	174	219
Callum	29 km E	125	210	124	137
Sturgeon Falls	77 km E	291	235	209	204
St. Charles	48 km SE	239	207	168	204
Burwash	27 km S	76	287	137	148
Tilton L.	15 km SW	---	---	---	193
Penage	37 km SW	176	237	173	255
Killarney	64 km SW	---	---	246	150
Nairn Centre	48 km WSW	223	349	216	324
Fairbanks L.	37 km W	---	---	---	216
Rayside Twp.	16 km NW	87	188	158	175
Morgan Twp.	24 km NW	205	280	166	179

* Control location

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1971 through 1973.

Table 40:

CONCENTRATIONS OF ZINC ($\mu\text{g/g}$) IN TREMBLING ASPEN
FOLIAGE SAMPLES COLLECTED IN THE SUDBURY AREA, 1970-1973**

Plot	Distance and Direction from Sudbury	Year			
		1970	1971	1972	1973
Blind River *	160 km W	283	265	209	258
Mattawa *	176 km E	262	212	257	242
Sudbury	0 km	84	124	93	89
Milnet	37 km N	238	141	250	152
Chiniguchi	57 km NNE	---	---	---	178
Garson	5 km NE	75	125	88	69
Skead	26 km NE	176	141	188	175
Kukagami L.	42 km NE	225	187	163	204
Grassy L.	64 km NE	163	152	115	135
Temagami	80 km NE	109	202	414	317
Callum	29 km E	131	280	152	136
Sturgeon Falls	77 km E	570	262	245	295
St. Charles	48 km SE	171	217	116	175
Burwash	27 km S	125	232	120	122
Tilton L.	15 km SW	---	---	---	204
Penage	37 km SW	191	130	248	199
Killarney	64 km SW	---	---	222	272
Nairn Centre	48 km WSW	265	233	194	257
Fairbanks L.	37 km W	---	---	---	305
Rayside Twp.	16 km NW	127	111	163	144
Morgan Twp.	24 km NW	156	215	161	200

* Control Location

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1971 through 1973.

Table 41:

CONCENTRATIONS OF ZINC ($\mu\text{g/g}$) IN JACK PINE
FOLIAGE SAMPLES COLLECTED IN THE SUDBURY AREA

1970 - 1973 **

Plot	Distance and Direction from Sudbury	1 Year Old Foliage				Current Year Foliage			
		1970	1971	1972	1973	1970	1971	1972	1973
Blind River*	160 km	92	47	44	48	66	70	47	58
Mattawa*	176 km E	83	92	105	95	74	66	74	77
Sudbury	0 km	17	23	25	19	53	24	25	25
Milnet	37 km N	48	40	45	49	55	40	46	53
Chiniguchi	57 km NNE	--	--	--	25	--	--	--	39
Garson	5 km NE	--	--	--	--	--	--	--	--
Skead	26 km NE	15	28	18	51	29	27	23	29
Kukagami L.	42 km NE	40	43	38	34	29	52	37	37
Grassy L.	64 km NE	33	41	45	40	44	43	50	48
Temagami	80 km NE	52	68	44	55	74	62	48	49
Callum	29 km E	28	25	45	18	20	30	47	30
Sturgeon Falls	77 km E	--	5	71	71	--	68	52	52
St. Charles	48 km SE	45	38	50	37	47	44	42	30
Burwash	27 km S	31	44	44	30	30	38	35	43
Tilton L.	15 km SW	--	--	--	--	--	--	--	--
Penage	37 km SW	46	13	26	--	30	55	26	--
Killarney	64 km SW	--	--	--	84	--	--	--	46
Nairn Centre	48 km WSW	55	78	60	46	46	64	52	55
Fairbanks L.	37 km W	--	--	--	37	--	--	--	45
Rayside Twp.	16 km NW	24	31	29	29	23	33	42	41
Morgan Twp.	24 km NW	33	40	36	41	40	88	40	41

* Control Location

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1971 through 1974.

Table 42:

CONCENTRATIONS OF ZINC ($\mu\text{g/g}$) IN BRACKEN FERN
FOLIAGE SAMPLES COLLECTED IN THE SUDBURY AREA, 1970 - 1973**

Plot	Distance and Direction from Sudbury	Year			
		1970	1971	1972	1973
Blind River *	160 km W	29	32	51	40
Mattawa *	176 km E	51	47	43	48
Sudbury	0 km	54	25	33	35
Milnet	37 km N	30	23	40	90
Chiniguchi	57 km NNE	--	--	--	33
Garson	5 km NE	29	34	24	32
Skead	26 km NE	24	40	41	34
Kukagami L.	42 km NE	33	20	28	24
Grassy L.	64 km NE	29	26	29	32
Temagami	80 km NE	34	41	40	37
Callum	29 km E	21	25	60	30
Sturgeon Falls	77 km E	35	69	27	38
St. Charles	48 km SE	29	29	42	31
Burwash	27 km S	28	26	35	34
Tilton L.	15 km SW	--	--	--	58
Penage	37 km SW	38	21	54	51
Killarney	64 km SW	--	--	50	46
Nairn Centre	48 km WSW	33	51	33	36
Fairbanks L.	37 km W	--	--	--	26
Rayside Twp.	16 km NW	26	33	32	41
Morgan Twp.	24 km NW	19	33	36	44

* Control location

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1971 through 1973

Table 43:

CONCENTRATIONS OF ZINC ($\mu\text{g/g}$) IN GRASS
FOLIAGE SAMPLES COLLECTED IN THE SUDBURY AREA
1970 - 1973

Plot	Distance and Direction from Sudbury	Year			
		1970	1971	1972	1973
Blind River *	160 km W	29	28	23	43
Mattawa *	176 km E	36	43	25	28
Sudbury	0 km	20	37	18	14
Milnet	37 km N	36	43	34	28
Chiniguchi	57 km NNE	--	--	--	39
Garson	5 km NE	20	21	24	18
Skead	26 km NE	42	17	21	32
Kukagami L.	42 km NE	40	42	26	19
Grassy L.	64 km NE	35	32	25	37
Temagami	80 km NE	27	21	16	25
Callum	29 km E	20	39	28	20
Sturgeon Falls	77 km E	25	42	18	24
St. Charles	48 km SE	27	22	24	25
Burwash	27 km S	22	33	32	20
Tilton L.	15 km SW	--	--	--	20
Penage	37 km SW	19	48	35	32
Killarney	64 km SW	--	--	34	46
Nairn Centre	48 km WSW	19	31	19	30
Fairbanks L.	37 km W	--	--	--	12
Rayside Twp.	16 km NW	22	25	30	25
Morgan Twp.	24 km NW	29	36	31	29

* Control Location

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1971 through 1973.

Table 44:

CONCENTRATIONS OF LEAD ($\mu\text{g/g}$) IN VEGETATION

SAMPLES COLLECTED IN THE SUDBURY AREA, 1973-1976**

Plot	Distance and Direction from Sudbury	Jack Pine (1 Year)	Jack Pine (Current)	Bracken Fern	Forage	Trembling Aspen	White Birch (1973)	White Birch (1975)	White Birch (1976)
Blind River	160 km W	3	4	6	4	3	6	8	4
Mattawa	176 km E	6	4	8	4	5	6	6	4
Sudbury	0 km	3	12	11	12	11	10	13	7
Milnet	37 km N	12	5	6	6	7	4	10	8
Chiniguchi	57 km NNE	6	5	9	7	7	9	8	8
Garson	5 km NE	--	--	10	6	5	5	12	7
Skead	26 km NE	17	5	7	5	8	6	13	10
Kukagami L.	42 km NE	7	2	6	4	6	3	9	8
Grassy L.	64 km NE	3	3	3	8	4	4	10	8
Temagami	80 km NE	4	5	5	4	5	6	10	8
Callum	29 km E	7	5	5	3	8	7	10	6
Sturgeon Falls	77 km E	2	2	5	3	5	6	10	5
St. Charles	48 km SE	5	4	3	3	4	4	10	5
Burwash	27 km S	12	5	7	4	8	10	12	12
Tilton L.	15 km SW	--	--	13	8	2	14	13	8
Penage	37 km SW	--	--	4	12	5	6	12	12
Killarney	64 km SW	4	3	7	4	7	8	11	14
Nairn Centre	48 km WSW	7	6	8	8	8	11	9	6
Fairbanks L.	37 km W	4	2	3	4	3	5	7	10
Rayside Twp.	16 km NW	6	5	7	5	7	6	10	11
Morgan Twp.	24 km NW	5	5	7	5	6	6	9	12

** Values reported are means of three monthly samples in 1973 and two monthly samples in triplicate in 1975 and 1976.

CONCENTRATIONS OF COBALT IN ($\mu\text{g/g}$) IN WHITE BIRCH FOLIAGE SAMPLES
COLLECTED IN THE SUDBURY AREA
1970 - 1973**

Plot	Distance and Direction from Sudbury	YEAR			
		1970	1971	1972	1973
Blind River*	160 km W	2	10	4	3
Mattawa*	176 km E	2	5	3	3
Sudbury	0 km	3	6	5	4
Milnet	37 km N	2	4	3	2
Chiniguchi	57 km NNE	--	--	--	3
Garson	5 km NE	2	3	3	3
Skead	26 km NE	2	5	5	3
Kukagami L.	42 km NE	2	5	3	5
Grassy L.	64 km NE	2	5	4	5
Temagami	80 km NE	2	6	3	3
Callum	29 km E	2	7	2	3
Sturgeon Falls	77 km E	2	6	3	3
St. Charles	48 km SE	2	8	2	4
Burwash	27 km S	2	4	3	2
Tilton L.	15 km SW	--	--	--	2
Penage	37 km SW	2	4	4	4
Killarney	64 km SW	--	--	3	2
Nairn Centre	48 km WSW	2	8	4	3
Fairbanks L.	37 km W	--	--	--	4
Rayside Twp.	16 km NW	2	4	3	2
Morgan Twp.	24 km NW	2	5	4	2

* Control location

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1971 through 1973.

Table 46:

CONCENTRATIONS OF COBALT ($\mu\text{g/g}$) IN TREMBLING ASPEN FOLIAGE
SAMPLES COLLECTED IN THE SUDBURY AREA

1970 - 1973**

Plot	Distance and Direction from Sudbury	YEAR			
		1970	1971	1972	1973
Blind River*	160 km W	2	10	3	3
Mattawa*	176 km E	2	5	3	2
Sudbury	0 km	1	12	9	4
Milnet	37 km N	3	6	4	3
Chiniguchi	57 km NNE	--	--	--	7
Garson	4 km NE	4	6	5	7
Skead	26 km NE	4	6	4	5
Kukagami L.	42 km NE	3	11	3	6
Grassy L.	64 km NE	2	12	5	10
Temagami	80 km NE	2	6	4	3
Callum	29 km E	4	13	6	8
Sturgeon Falls	77 km E	2	10	4	2
St. Charles	48 km SE	3	11	3	4
Burwash	27 km S	2	7	6	2
Tilton L.	15 km SW	--	--	5	4
Penage	37 km SW	3	9	6	7
Killarney	64 km SW	--	--	5	4
Nairn Centre	48 km WSW	3	8	5	5
Fairbanks L.	37 km W	--	--	--	4
Rayside Twp.	16 km NW	5	6	7	5
Morgan Twp.	24 km WN	2	6	6	4

* Control location

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1971 through 1973.

Table 47:

CONCENTRATIONS OF COBALT ($\mu\text{g/g}$) IN JACK PINE
FOLIAGE SAMPLES COLLECTED IN THE SUDBURY AREA

1970 - 1973 **

Plot	Distance and Direction from Sudbury	1 Year Old Foliage				Current Year Foliage			
		1970	1971	1972	1973	1970	1971	1972	1973
Blind River*	160 km W	2	3	2	3	2	5	3	3
Mattawa*	176 km E	2	3	2	1	2	2	2	2
Sudbury	0 km	2	5	3	2	2	5	2	2
Milnet	37 km N	2	3	2	2	2	5	2	2
Chiniguchi	57 km NNE	-	-	-	2	-	-	2	2
Garson	5 km NE	-	-	-	-	-	-	-	-
Skead	26 km NE	2	2	2	2	2	4	2	2
Kukagami L.	42 km NE	2	5	1	3	2	6	6	6
Grassy L.	64 km NE	2	4	2	5	2	3	5	5
Temagami	80 km NE	2	2	2	3	2	3	5	5
Callum	29 km E	2	4	2	2	2	5	3	3
Sturgeon Falls	77 km E	-	5	2	2	-	2	1	1
St. Charles	48 km SE	2	4	2	4	2	3	3	3
Burwash	27 km S	2	3	2	2	2	3	2	2
Tilton L.	15 km SW	-	-	-	-	-	-	-	-
Penage	37 km SW	2	8	2	-	2	4	-	-
Killarney	64 km SW	-	-	-	-	-	-	2	2
Nairn Centre	48 km WSW	2	4	2	5	2	3	5	5
Fairbanks L.	37 km W	-	-	-	4	-	-	3	3
Rayside Twp.	16 km NW	2	4	4	1	2	5	1	1
Morgan Twp.	24 km NW	2	3	2	2	2	11	2	3

* Control location

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1971 through 1974.

CONCENTRATIONS OF COBALT ($\mu\text{g/g}$) IN BRACKEN FERN FOLIAGE

SAMPLES COLLECTED IN THE SUDBURY AREA

1970 - 1973**

Plot	Distance and Direction from Sudbury	YEAR			
		1970	1971	1972	1973
Blind River*	160 km W	2	7	2	2
Mattawa*	176 km E	2	4	5	1
Sudbury	0 km	2	8	4	2
Milnet	37 km N	2	4	2	2
Chiniguchi	57 km NNE	--	--	--	4
Garson	5 km NE	2	5	2	3
Skead	26 km NE	2	6	2	3
Kukagami L.	42 km NE	2	10	3	3
Grassy L.	64 km NE	2	4	3	4
Temagami	80 km NE	2	6	3	3
Callum	29 km E	2	8	2	5
Sturgeon Falls	77 km E	2	7	3	3
St. Charles	48 km SE	2	7	2	4
Burwash	27 km S	2	8	2	3
Tilton L.	15 km SW	--	--	--	2
Penage	37 km SW	2	4	3	5
Killarney	64 km SW	--	--	2	2
Nairn Centre	48 km WSW	2	7	3	3
Fairbanks L.	37 km W	--	--	--	4
Rayside Twp.	16 km NW	2	5	3	1
Morgan Twp.	24 km NW	2	4	3	2

* Control location

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1971 through 1973.

Table 49:

CONCENTRATIONS OF COBALT ($\mu\text{g/g}$) IN GRASS FOLIAGE SAMPLES
COLLECTED IN THE SUDBURY AREA
1970 - 1973**

Plot	Distance and Direction from Sudbury	YEAR			
		1970	1971	1972	1973
Blind River*	160 km W	2	3	2	1
Mattawa*	176 km E	2	5	3	3
Sudbury	0 km	2	5	3	3
Milnet	37 km N	2	4	2	2
Chiniguchi	57 km NNE	--	--	--	2
Garson	5 km NE	2	4	3	2
Skead	26 km NE	2	3	2	3
Kukagami L.	42 km NE	2	5	2	2
Grassy L.	64 km NE	2	4	1	4
Temagami	80 km NE	2	5	2	2
Callum	29 km E	2	5	2	3
Sturgeon Falls	77 km E	2	5	3	2
St. Charles	48 km SE	2	4	3	3
Burwash	27 km S	2	4	2	3
Tilton L.	15 km SW	--	--	--	2
Penage	37 km SW	2	4	2	4
Killarney	64 km SW	--	--	--	2
Nairn Centre	48 km WSW	2	4	1	3
Fairbanks L.	37 km W	--	--	--	4
Rayside Twp.	16 km NW	2	2	2	1
Morgan Twp.	24 km NW	2	5	3	2

* Control location

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1971 through 1973.

Table 50:

CONCENTRATIONS OF FLUORIDE ($\mu\text{g/g}$) IN VEGETATION
 SAMPLES COLLECTED IN THE SUDBURY AREA, 1970 **

Plot	Distance and Direction From Sudbury	Jack Pine (1 Year)	Jack Pine (Current)	Bracken Fern	Forage	White Birch	Trembling Aspen	Soil ***
Blind River*	160 km W	1	1	0	0	0	3	140
Mattawa*	176 km E	4	3	1	3	3	2	185
Sudbury	0 km	3	2	1	2	3	2	50
Milnet	37 km N	4	2	2	2	6	3	75
Chiniguchi	57 km NNE	-	-	-	-	-	-	--
Garson	5 km NE	-	-	3	5	4	3	55
Skead	26 km NE	4	1	3	3	3	3	80
Kukagami L.	42 km NE	4	3	1	1	2	3	90
Grassy L.	64 km NE	0	0	1	2	0	0	185
Temagami	80 km NE	1	0	0	2	2	4	110
Callum	29 km E	2	3	1	1	2	2	80
Sturgeon Falls	77 km E	-	-	0	2	4	5	165
St. Charles	48 km SE	2	1	2	2	3	2	115
Burwash	27 km S	2	1	2	2	4	4	75
Tilton L.	15 km SW	-	-	-	-	-	-	---
Penage	37 km SW	1	1	4	1	1	2	135
Killarney	64 km SW	-	-	-	-	-	-	---
Nairn Centre	48 km WSW	2	1	2	0	2	2	170
Fairbanks L.	37 km W	-	-	-	-	-	-	---
Rayside Twp.	16 km NW	2	0	0	2	3	6	95
Morgan Twp.	24 km NW	3	1	2	2	3	3	50

* Control location

** Values reported are means of four monthly samples in 1970.

*** Soil Depth 0-10 cm

Table 51:

CONCENTRATIONS OF SULPHUR (%) IN SOIL
 SAMPLES COLLECTED IN THE SUDBURY AREA

1970 - 1976 **

Plot	Distance and Direction from Sudbury	Year ***						
		1970	1971	1972	1973	1974	1975	1976
Blind River *	160 km W	.02	.03	.04	.02	.03	.04	.03
Mattawa *	176 km E	.01	.04	.01	.02	.02	.02	.02
Sudbury	0 km	.02	.03	.06	.04	.04	.06	.03
Milnet	37 km N	.04	.03	.03	.02	.04	.04	.03
Chiniguchi	57 km NNE	---	---	---	.05	.02	.04	.03
Garson	5 km NE	.03	.05	.03	.03	.05	.04	.03
Skead	26 km NE	.04	.10	.04	.08	.05	.10	.04
Kukagami L.	42 km NE	.05	.06	.05	.02	.04	.05	.04
Grassy L.	64 km NE	.04	.03	.03	.05	.04	.05	.07
Temagami	80 km NE	.04	.02	.03	.02	.03	.03	.03
Callum	29 km E	.04	.05	.04	.03	.04	.05	.03
Sturgeon Falls	77 km E	.03	.05	.03	.04	.03	.05	.03
St. Charles	48 km SE	.04	.05	.03	.04	.03	.05	.03
Burwash	27 km S	.02	.05	.03	.03	.02	.03	.04
Tilton L.	15 km SW	---	---	---	.05	.06	.05	.04
Penage	37 km SW	.03	.09	.02	.03	.03	.05	.06
Killarney	64 km SW	---	---	.05	.03	.04	.04	.03
Bairn Centre	48 km WSW	.03	.09	.02	.04	.04	.04	.44
Fairbanks L.	37 km W	---	---	---	.04	.04	.04	.02
Rayside Twp.	16 km NW	.03	.03	.03	.04	.03	.04	.03
Morgan Twp.	24 km NW	.01	.03	.02	.02	.02	.03	.02

* Control Location

** Soil Depth 0 - 10 cm

*** Values reported are means of four monthly samples in 1970, three monthly samples in 1971 through 1974 and two monthly samples in triplicate in 1975 and 1976.

Table 52:

CONCENTRATIONS OF NICKEL ($\mu\text{g/g}$) IN SOIL
 SAMPLES COLLECTED IN THE SUDBURY AREA, 1970 - 1976**

Plot	Distance and Direction from Sudbury	Year ***						
		1970	1971	1972	1973	1974	1975	1976
Blind River *	160 km W	11	2	11	4	16	15	12
Mattawa *	176 km E	7	5	28	4	10	18	24
Sudbury	0 km	245	149	235	187	92	343	87
Milnet	37 km N	50	18	20	60	26	26	34
Chiniguchi	57 km NNE	--	--	--	19	25	42	63
Garson	5 km NE	215	86	76	97	50	155	138
Skead	26 km NE	150	135	116	132	169	87	77
Kukagami L.	42 km NE	85	42	83	37	45	77	68
Grassy L.	64 km NE	68	53	40	34	48	63	49
Temagami	80 km NE	40	32	28	19	36	33	61
Callum	29 km E	60	48	94	55	29	134	58
Sturgeon Falls	77 km E	39	34	65	19	26	23	25
St. Charles	48 km SE	31	45	63	25	34	32	43
Burwash	27 km S.	44	59	27	73	26	26	72
Tilton L.	15 km SW	--	--	--	95	76	170	98
Penage	37 km SW	79	49	44	29	53	89	59
Killarney	64 km SW	--	--	20	14	20	22	19
Nairn Centre	48 km WSW	52	40	38	23	53	37	36
Fairbanks L.	37 km W	--	--	43	19	34	38	31
Rayside Twp.	16 km NW	85	37	136	62	87	170	72
Morgan Twp.	24 km NW	43	23	42	24	19	34	30

* Control location

** Soil Depth 0 - 10 cm

*** Values reported are means of four monthly samples in 1970, three monthly samples in 1971 through 1974 and two monthly samples in triplicate in 1975 and 1976.

CONCENTRATIONS OF COPPER ($\mu\text{g/g}$) IN SOIL
 SAMPLES COLLECTED IN THE SUDBURY AREA
 1970 -1976 **

Plot	Distance and Direction from Sudbury	YEAR***						
		1970	1971	1972	1973	1974	1975	1976
Blind River*	160 km W	10	18	5	5	26	7	7
Mattawa*	176 km E	7	7	3	4	6	9	7
Sudbury	0 km	265	173	187	268	82	216	106
Milnet	37 km N	33	19	16	9	5	17	17
Chiniguchi	57 km NNE	--	--	--	14	15	35	20
Garson	5 km NE	174	105	57	87	56	100	127
Skead	26 km NE	125	170	181	179	182	80	92
Kukagami L.	42 km NE	102	35	119	40	32	52	62
Grassy L.	64 km NE	57	28	44	41	34	60	40
Temagami	80 km NE	51	22	39	18	34	37	28
Callum	20 km E	94	37	75	30	18	103	48
Sturgeon Falls	77 km E	23	16	23	20	31	22	15
St. Charles	48 km SE	21	24	12	12	25	24	23
Burwash	27 km S	27	39	10	29	4	15	44
Tilton L.	15 km SW	--	--	--	125	26	118	72
Penage	37 km SW	58	82	31	32	28	99	75
Killarney	64 km SW	--	--	--	43	8	10	15
Nairn Centre	48 km WSW	44	17	40	78	24	30	42
Fairbanks L.	37 km W	--	--	--	16	43	26	36
Rayside Twp.	16 km NW	67	45	88	68	68	138	72
Morgan Twp.	24 km NW	29	20	18	16	14	17	18

* Control location

** Soil Depth 0-10 cm

*** Values reported are means of four monthly samples in 1970, three monthly samples in 1971 through 1974 and two monthly samples in triplicate in 1975 and 1976.

Table 54:

CONCENTRATIONS OF IRON (%) IN SOIL

SAMPLES COLLECTED IN THE SUDBURY AREA, 1970 - 1976**

Plot	Distance and Direction from Sudbury	Year ***						
		1970	1971	1972	1973	1974	1975	1976
Blind River *	160 km W	.15	.67	.95	.95	1.07	.98	.67
Mattawa *	176 km E	.39	.65	.65	.46	.56	.94	.72
Sudbury	0 km	1.58	1.15	1.15	.51	1.35	1.30	1.04
Milnet	37 km N	.97	.56	.56	.64	.97	.98	.87
Chiniguchi	57 km NNE	---	---	---	.67	1.25	.98	1.61
Garson	5 km NE	1.02	.69	.69	.43	.80	1.27	.78
Skead	26 km NE	1.12	1.20	1.20	1.01	.83	1.46	1.26
Kukagami L.	42 km NE	1.60	1.28	1.28	1.23	1.65	1.10	1.38
Grassy L.	64 km NE	.60	1.75	1.75	.62	1.38	2.05	1.67
Temagami	80 km NE	.98	.35	.35	.69	1.71	2.15	1.87
Callum	29 km E	1.13	1.32	1.32	.49	1.10	1.19	1.09
Sturgeon Falls	77 km E	.17	1.05	1.05	.14	1.49	1.24	.80
St. Charles	48 km SE	---	1.52	1.52	.78	1.43	1.17	1.56
Burwash	27 km S	1.15	1.33	1.33	.44	.92	1.22	1.71
Tilton L.	15 km SW	---	---	---	.79	1.80	1.26	1.18
Penage	37 km SW	.14	.14	1.29	.64	1.52	1.96	1.17
Killarney	64 km SW	---	---	---	.31	1.12	1.08	.65
Nairn Centre	48 km WSW	.24	.24	.48	1.42	1.92	1.56	1.01
Fairbanks L.	37 km W	---	---	---	1.40	1.35	1.61	1.87
Rayside Twp.	16 km NW	.97	.97	.67	.24	1.11	1.08	.54
Morgan Twp.	24 km NW	1.16	1.16	1.17	.39	.63	1.10	.63

* Control Location

** Soil Depth 0 -10 cm

*** Values reported are means of four monthly samples in 1970, three monthly samples in 1971 through 1974, and two monthly samples in triplicate in 1975 and 1976.

Table 55:

CONCENTRATIONS OF ARSENIC ($\mu\text{g/g}$) IN SOIL
 SAMPLES COLLECTED IN THE SUDBURY AREA 1970 - 1976**

Plot	Distance and Direction from Sudbury	1970	1971	1972	YEAR*** 1973	1974	1975	1976
Blind River*	160 km W	1.7	4.4	2.2	2.3	2.4	1.4	.9
Mattawa*	176 km E	2.3	3.8	2.9	.9	1.2	.8	.8
Sudbury	0 km	10.2	18.4	12.4	8.7	6.9	16.9	5.9
Milnet	37 km N	7.2	4.8	3.0	5.9	2.9	2.8	7.6
Chiniguchi	57 km NNE	---	---	---	3.9	3.0	7.1	1.9
Garson	5 km NE	9.8	26.0	7.6	10.4	4.4	14.1	6.6
Skead	26 km NE	13.1	47.0	43.7	8.0	10.4	16.2	11.0
Kukagami L.	42 km NE	11.7	6.4	13.4	6.3	5.4	7.9	6.7
Grassy L.	64 km NE	7.0	6.6	11.4	5.9	8.4	8.1	4.2
Temagami	80 km NE	4.0	7.0	8.0	2.4	3.3	2.5	3.6
Callum	29 km E	11.0	7.7	3.2	2.6	2.7	8.6	4.7
Sturgeon Falls	77 km E	5.6	5.6	4.4	2.5	2.0	1.7	1.0
St. Charles	48 km SE	7.3	6.5	3.2	2.6	2.8	2.9	2.4
Burwash	27 km S	3.4	6.7	5.8	3.2	1.4	1.1	3.7
Tilton L.	15 km SW	---	---	---	8.5	8.9	19.5	7.9
Penage	37 km SW	7.2	8.7	9.8	3.7	4.8	4.1	5.1
Killarney	64 km SW	---	---	5.8	2.2	2.2	4.2	1.3
Nairn Centre	48 km WSW	3.9	4.8	1.2	2.5	3.9	4.0	3.5
Fairbanks L.	37 km W	---	---	---	9.7	6.3	5.9	6.7
Rayside Twp.	16 km NW	7.0	8.0	7.7	6.6	7.3	13.2	6.0
Morgan Twp.	24 km NW	3.4	2.9	4.2	2.5	1.2	2.0	1.0

* Control location

** Soil Depth 0 - 10 cm

*** Values reported are means of four monthly samples in 1970, three monthly samples in 1971 through 1974 and two monthly samples in triplicate in 1975 and 1976.

Table 56:

-99-

CONCENTRATIONS OF SELENIUM ($\mu\text{g/g}$) IN SOIL
 SAMPLES COLLECTED IN THE SUDBURY AREA 1970 - 1972***

Plot	Distance and Direction From Sudbury	YEAR **	
		1970	1972
Blind River*	160 km W	.75	.23
Mattawa*	176 km E	.08	.20
Sudbury	0 km	---	1.02
Milnet	37 km N	---	.34
Chiniguchi	57 km NNE	---	---
Garson	5 km NE	1.52	.35
Skead	26 km NE	.29	.64
Kukagami L.	42 km NE	.47	.80
Grassy L.	64 km NE	.32	.23
Temagami	80 km NE	.30	.40
Callum	29 km E	---	.36
Sturgeon Falls	77 km E	---	.41
St. Charles	48 km SE	---	.34
Burwash	27 km S	---	.36
Tilton L.	15 km SW	---	---
Penage	37 km SW	.40	.23
Killarney	64 km SW	---	.25
Nairn Centre	48 km WSW	---	.37
Fairbanks L.	37 km N	---	---
Rayside Twp.	16 km NW	---	.42
Morgan Twp.	24 km NW	---	.23

* Control location

** Values reported are means of four monthly samples in 1970 and three monthly samples in 1972

*** Soil Depth 0-10 cm

Table 57:

CONCENTRATIONS OF ZINC ($\mu\text{g/g}$) IN SOIL SAMPLES
COLLECTED IN THE SUDBURY AREA
1970 - 1973 **

Plot	Distance and Direction from Sudbury	YEAR ***			
		1970	1971	1972	1973
Blind River*	160 km W	37	42	37	37
Mattawa*	176 km E	28	37	20	16
Sudbury	0 km	30	93	43	27
Milnet	37 km N	40	34	32	10
Chiniguchi	57 km NNE	--	--	--	15
Garson	5 km NE	23	64	11	20
Skead	26 km NE	85	77	34	34
Kukagami L.	42 km NE	43	44	26	38
Grassy L.	64 km NE	114	72	43	38
Temagami	80 km NE	53	52	35	17
Callum	29 km E	49	89	33	42
Sturgeon Falls	77 km E	72	174	75	72
St. Charles	48 km SE	45	108	103	31
Burwash	27 km S	32	69	20	18
Tilton L.	15 km SW	--	--	--	52
Penage	37 km SW	173	50	44	28
Killarney	64 km SW	--	--	84	25
Nairn Centre	48 km WSW	81	64	87	60
Fairbanks L.	37 km W	--	--	--	45
Rayside Twp.	16 km NW	22	25	14	14
Morgan Twp.	24 km NW	28	29	78	20

* Control location

** Soil Depth 0-10 cm

*** Values reported are means of four monthly samples in 1970,
and three monthly samples in 1971-1973.

CONCENTRATIONS OF LEAD ($\mu\text{g/g}$) IN SOIL SAMPLES
COLLECTED IN THE SUDBURY AREA
1973 - 1976 **

Plot	Distance and Direction from Sudbury	YEAR ***		
		1973	1975	1976
Blind River*	160 km W	14	22	16
Mattawa*	176 km E	ND	12	12
Sudbury	0 km	25	28	15
Milnet	37 km N	ND	27	26
Chiniguchi	57 km NNE	ND	21	22
Garson	5 km NE	8	18	18
Skead	26 km NE	46	26	25
Kukagami L.	42 km NE	10	30	25
Grassy L.	64 km NE	23	45	37
Temagami	80 km NE	11	20	24
Callum	29 km E	13	34	12
Sturgeon Falls	77 km E	18	26	15
St. Charles	48 km SE	13	24	17
Burwash	27 km S	4	21	35
Tilton L.	15 km SW	19	24	26
Penage	37 km SW	19	67	35
Killarney	64 km SW	12	17	30
Nairn Centre	48 km WSW	20	36	40
Fairbanks L.	37 km W	10	20	31
Rayside Twp.	16 km NW	5	33	24
Morgan Twp.	24 km NW	8	16	28

* control location

** soil depth 0-10 cm

*** Values reported are means of three monthly samples in 1973 and two monthly samples in triplicate in 1975 and 1976.

Table 59:

CONCENTRATIONS OF COBALT ($\mu\text{g/g}$) IN SOIL SAMPLES
COLLECTED IN THE SUDBURY AREA
1970 - 1973 **

Plot	Distance and Direction from Sudbury	YEAR ***			
		1970	1971	1972	1973
Blind River*	160 km W	6	6	6	15
Mattawa*	176 km E	2	4	4	5
Sudbury	0 km	9	13	13	11
Milnet	37 km N	6	17	17	4
Chiniguchi	57 km NNE	--	--	--	7
Garson	5 km NE	8	8	8	6
Skead	26 km NE	9	10	10	10
Kukagami L.	42 km NE	7	13	13	10
Grassy L.	64 km NE	20	10	10	6
Temagami	80 km NE	10	13	13	7
Callum	29 km E	9	20	20	9
Sturgeon Falls	77 km E	7	13	13	8
St. Charles	48 km SE	6	8	8	8
Burwash	27 km S	8	10	10	8
Tilton L.	15 km SW	--	--	--	7
Penage	37 km SW	9	10	10	10
Killarney	64 km SW	--	8	8	7
Nairn Centre	48 km WSW	7	11	11	4
Fairbanks L.	37 km W	--	--	--	17
Rayside Twp.	16 km NW	3	7	7	4
Morgan Twp.	24 km NW	8	7	7	6

* Control location

** Soil Depth 0-10 cm

*** Values reported are means of four monthly samples in 1970 and three monthly samples in 1970 through 1973.

Table 60:

CONCENTRATIONS OF CALCIUM ($\mu\text{g/g}$) IN SOIL SAMPLES
COLLECTED IN THE SUDBURY AREA
1973 - 1976 **

Plot	Distance and Direction from Sudbury	YEAR ***			
		1973	1974	1975	1976
Blind River*	160 km W	269	1188	2470	2000
Mattawa*	176 km E	179	739	2570	1800
Sudbury	0 km	159	660	1503	100
Milnet	37 km N	135	282	1793	600
Chiniguchi	57 km NNE	62	275	----	200
Garson	5 km NE	162	571	1200	500
Skead	26 km NE	30	497	336	400
Kukagami L.	42 km NE	107	558	1237	800
Grassy L.	64 km NE	323	1690	3977	500
Temagami	80 km NE	173	924	1160	900
Callum	29 km E	311	1035	1830	900
Sturgeon Falls	77 km E	1288	2110	542	1200
St. Charles	48 km SE	311	1743	1860	1600
Burwash	27 km S	188	288	2700	2800
Tilton L.	15 km SW	42	116	1052	300
Penage	37 km SW	645	2127	1.70%	5300
Killarney	64 km SW	334	222	693	800
Nairn Centre	48 km WSW	392	458	1870	1400
Fairbanks L.	37 km W	34	350	1191	600
Rayside Twp.	16 km NW	155	643	537	3000
Morgan Twp.	24 km NW	643	3177	1830	3000

* Control location

** Soil Depth 0-10 cm

*** Values reported are means of three monthly samples in 1973 and 1974 and two monthly values in triplicate in 1975 and 1976.

CONCENTRATIONS OF MAGNESIUM ($\mu\text{g/g}$) IN SOIL SAMPLES
COLLECTED IN THE SUDBURY AREA
1973 - 1976 **

Plot	Distance and Direction from Sudbury	YEAR ***			
		1973	1974	1975	1976
Blind River*	160 km W	711	1850	1303	800
Mattawa*	176 km E	363	987	2097	1200
Sudbury	0 km	1973	1927	2210	1000
Milnet	37 km N	1040	1425	2027	1100
Chiniguchi	57 km NNE	700	1762	--	1100
Garson	5 km NE	1230	900	1450	1500
Skead	26 km NE	299	775	1006	1200
Kukagami L.	42 km NE	882	1483	847	1800
Grassy L.	64 km NE	884	4500	4500	4000
Temagami	80 km NE	1063	3187	1887	1400
Callum	29 km E	1120	2010	1177	2200
Sturgeon Falls	77 km E	1360	3270	600	1400
St. Charles	48 km SE	1120	2837	1937	2200
Burwash	27 km S	1255	1230	4487	4700
Tilton L.	15 km SW	697	5650	1993	900
Penage	37 km SW	2725	4760	7667	3400
Killarney	64 km SW	506	780	1237	1200
Nairn Centre	48 km WSW	1415	3090	1687	1800
Fairbanks L.	37 km W	1367	3425	2177	2800
Rayside Twp.	16 km NW	1050	1303	727	700
Morgan Twp.	24 km NW	1665	2487	2093	3800

* Control location

** Soil Depth 0-10 cm

*** Values reported are means of three monthly samples in 1973 and 1974 and two monthly samples in triplicate in 1975 and 1976.

Table 1:

SUMMARY OF pH VALUES DETERMINED FOR SOIL SAMPLES COLLECTED

IN THE SUDBURY AREA - 1970 - 1975

Location	June/70	Aug/70	June/71	Aug/71	June/72	Aug/72	June/73	Aug/73	July/75	Aug/75	pH Range
Skead	4.2	4.2	4.2	4.3	4.2	4.2	3.9	5.1	4.4	4.7	3.9-5.1
Milnet	3.9	4.3	4.2	4.2	4.6	5.3	4.9	5.1	4.9	5.2	3.9-5.3
Rayside	3.8	4.2	4.6	4.9	4.5	4.2	4.1	4.3	4.5	5.3	3.8-5.3
Grassy Lake	4.6	4.5	5.2	5.2	4.2	5.7	4.2	4.4	5.4	5.1	4.2-5.7
Kukagami	4.8	4.0	4.6	5.0	4.3	4.1	4.5	4.2	4.1	4.6	4.1-5.0
Callum	4.9	4.3	4.3	5.0	5.7	4.3	4.6	4.5	4.5	4.9	4.3-5.7
Garson	4.7	3.9	4.0	4.1	4.3	4.5	4.1	4.3	5.3	4.9	3.9-5.3
Burwash	5.2	5.2	4.6	4.3	5.2	5.2	4.6	4.8	5.2	4.9	4.3-5.2
Sudbury	4.0	4.0	4.3	4.9	4.7	4.0	4.3	4.4	5.2	4.7	4.0-5.2
Morgan	5.1	4.9	5.1	5.9	4.7	5.6	4.1	5.5	5.1	5.5	4.1-5.9
St. Charles	5.3	5.2	4.3	4.4	5.2	5.2	5.3	5.0	5.0	5.1	4.3-5.3
L. Penage	5.6	4.0	5.2	4.2	4.6	4.4	5.0	4.8	6.2	5.4	4.0-6.2
Sturgeon Falls	4.2	4.6	4.3	4.9	4.8	5.5	5.3	5.3	4.7	5.1	4.2-5.5
Nairn	3.9	4.6	4.6	6.3	5.2	5.4	4.9	4.5	4.8	5.4	3.9-6.3
Temagami	4.5	4.3	4.7	4.2	4.9	4.9	4.7	4.3	4.7	4.8	4.2-4.9
Killarney	--	--	--	--	4.7	3.0	4.6	4.5	5.0	4.9	3.0-5.0
Fairbanks	--	--	--	--	--	--	4.7	4.3	5.1	5.4	4.3-5.4
Tilton	--	--	--	--	--	--	4.5	4.5	4.4	4.7	4.4-4.7
Chiniguchi	--	--	--	--	--	--	4.0	4.5	4.2	4.5	4.0-4.5
Blind River*	4.3	5.2	4.5	4.5	4.6	5.2	5.1	5.1	5.6	5.6	4.3-5.6
Mattawa*	4.6	5.0	4.7	4.5	5.6	5.3	5.3	4.8	5.1	4.7	4.5-5.6

* - Control Locations

** - Values reported are means of triplicate samples.

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